Vol. 31 Part 2.

Rubber Research Institute of Ceylon

Second Quarterly Circular for 1955

June, 1955

Rubber Research Institute of Ceylon

BOARD OF MANAGEMENT

Ex-Officio Members

The Director of Agriculture—Dr. A. W. R. Joachim, O.B.E., Ph.D., F.R.I.C.
The Deputy Secretary to the Treasury—R. H. Wickramasinghe, M.B.E., C.C.S.
The Rubber Controller—Mr. B. Mahadeva, M.A., C.C.S.
The Director, Rubber Research Institute of Ceylon—Dr. H. E. Young, D.Sc. Agr., A.I.R.I. (Vice-Chairman)

Members of Parliament nominated by the Hon'ble Minister of Agriculture and Food:

Senator C. F. W. Wickramasinghe, B.Sc.
Major T. F. Jayewardene, M.P.

Members nominated by the Planters' Association of Ceylon:

Mr. H. St. J. Cole-Bowen, (Acting)
Mr. G. H. Dulling

Members nominated by the Low-Country Products Association of Ceylon :

Mr. S. Pathmanathan (*Chairman*)
Mr. Errol A. Jayawickreme, J.P., U.M.

Member nominated by the Hon'ble Minister of Agriculture and Food to represent Smallholders:

Mr. W. P. H. Dias, J.P.

Experimental Committee:

Mr. S. Pathmanathan (*Chairman*)
Mr. W. P. H. Dias, J.P.
Dr. A. W. R. Joachim, O.B.E., Ph.D., F.R.I.C.
Mr. B. Mahadeva, M.A., C.C.S.
Mr. H. St. J. Cole-Bowen, (Acting)
Mr. G. H. Dulling
Dr. H. E. Young (*Director*)

Smallholdings Committee:

Mr. S. Pathmanathan (*Chairman*)
Mr. W. P. H. Dias, J.P.
Dr. H. E. Young (*Director*)

CONTENTS

RUBBER RESEARCH INSTITUTE OF CEYLON.

SECOND QUARTERLY CIRCULAR FOR 1955.

Erratum

Page 39, line 4 ... ... *After* 'type' *insert* 'of work'.

Page 51, line 3 from bottom ... *Change* 'texts' *to* 'tests'.

NOTICES

DARTONFIELD GROUP—VISITORS' DAY

Those who wish to visit the Institute are requested to do so after making an appointment. No special days are set apart as Visitors' Days and the services of the technical officers can be availed of for discussion or demonstration only by prior appointment.

PUBLICATIONS

Rubber Research Institute publications comprising Annual Reports, Quarterly Circulars and occasional Bulletins and Advisory Circulars are available without charge to the Proprietors (resident in Ceylon), Superintendents and Local Agents of rubber estates in Ceylon over 30 acres in extent. Advisory Circulars and Smallholdings Leaflets in English or Sinhalese will be available without charge to Smallholders on application. Forms of application can be supplied on request.

It will be appreciated if subscribers will return any back publications which are of no use to them.

ADVISORY CIRCULARS

The undernoted Circulars may be obtained on application at 30 cents per copy. Future issues in the series will be sent free of charge to estates and smallholders registered for the receipt of our publications:—

(1) Notes on Budgrafting Procedure (Revised May, 1952).
(5) Straining box for latex (January, 1940).
(6) Notes on the care of Budded Trees of Clone Tjirandji 1 with special reference to Wind Damage (September, 1938).
(12) Warm Air Drying House for Crepe Rubber (Reprinted 1952).
(19) Density of Planting and Thinning out (December, 1942).
(21) The Control of Bark Rot and Canker (Revised 1952).
(32) Crown Budding for Oidium Resistance (Revised October, 1954).
(33) Mechanical Felling of Rubber Trees (Reprinted March, 1955).
(36) Contour Lining, Holing and Filling, Cutting of Platforms, Trenches and Drains (Superseding Circular No. 4) (February, 1953).
(37) Manuring of Rubber (Superseding Circular No. 30) (March, 1953).
(37A) Manuring—Magnesium Deficiencies in Rubber (July, 1954).
(37B) Potassium Deficiencies (September, 1954).
(38) Planting and After Care of Budded Stumps and Stumped Budgrafts (Superseding Circular No. 8) (March, 1953).
(39) Clonal Seed as Planting Material (Superseding Circulars No. 26 and 27) (July, 1953).
(40) Tapping of Hevea Rubber (Superseding Circulars No. 17 and 34) (June, 1954).

(41) Pink Disease (June, 1954).
(42) Sale of Budwood (June, 1954).
(43) Oidium Leaf Disease (Superseding Circulars No. 22 and 28) (June, 1954).
(44) Diplodia Dieback and Collar Rot of Hevea and Blue Spot of Crepe Rubber (June, 1954).
(45) Phytophthora Leaf Disease and Stem Dieback of Hevea (October, 1954).
(46) White Root Disease of Hevea (Leptoporus Lignosus=Fomes Lignosus) (October, 1954).
(47) Ustulina Rot of Rubber Trees (November, 1954).
(48) Brown Root Disease of Hevea (October, 1954).
(49) Root Disease in Replanted Areas (Superseding Circular No. 31) (October, 1954).
(50) Orange Gall of Hevea (December, 1954).
(51) Bird's Eye Leaf Spot of Hevea (December, 1954).
(52) A Guide to the Cost of Replanting Rubber (December, 1954).
(53) Prevention of Coagulation in the Field (Superseding 2nd Supplement to Advisory Circular No. 17) (March, 1955).

THE DETERMINATION OF THE DRY RUBBER CONTENT OF NATURAL RUBBER LATEX. PART III—METHODS FOR FRESH LATEX WITH SPECIAL REFERENCE TO THE USE OF THE METROLAC

BY

E. J. Risdon and The Staff of the Chemical Dept.*

1. **Introduction.**—Previous papers in this series have dealt primarily with the determination of the d.r.c. (dry rubber content) of ammoniated latex (5) and with the effect of ammoniation and of short term storage on the d.r.c. of fresh latex in Ceylon (6). To Estates selling rubber in the form of ammoniated fresh latex both these subjects are of importance. This paper deals primarily with what may appear from the Planter's viewpoint to be a less complex subject—the use (and abuse) of the metrolac. It is, however, patently clear from the correspondence of the R.R.I.C. that the limitations of latex hydrometers (metrolacs, latexometers and simplexometers) are not always fully appreciated in Ceylon. For example, it would appear to be the view of a number of Planters that the O'Brien (R.R.S.) scale metrolac, while ensuring a 'satisfactory' excess of actual total 'factory' dry rubber over total dry rubber estimated from tappers' output figures, is, at the same time, capable of providing reliable estimates (for yield and other purposes) of the actual dry rubber turned in by tappers dealing with latex from different clones and from different areas. This view often implies that the sum of the individual estimates of the rubber turned in by the tappers will be a marked underestimate at a time when the metrolac based estimates of any individual tapper's output is regarded as correct (or as a fixed percentage of the correct figure).

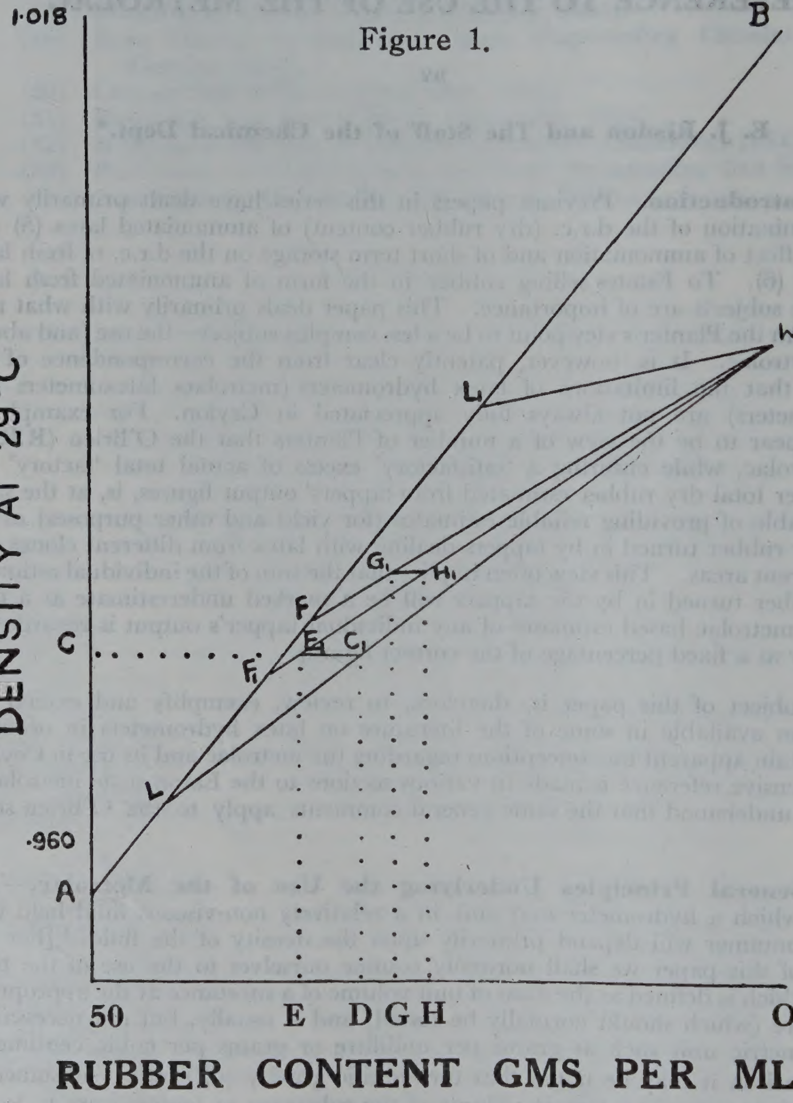
The object of this paper is, therefore, to review, exemplify and extend the information available in some of the literature on latex hydrometers in order to clarify certain apparent misconceptions regarding the metrolac and its use in Ceylon. While extensive reference is made in various sections to the Eaton scale metrolac it should be understood that the same general comments apply to the O'Brien scale metrolac.

2. **General Principles Underlying the Use of the Metrolac.**—The depth to which a hydrometer may sink in a relatively non-viscous fluid held in a suitable container will depend primarily upon the density of the fluid. [For the purposes of this paper we shall normally confine ourselves to the use of the term 'density' which is defined as the mass of unit volume of a substance at the appropriate temperature (which should normally be stated) and is usually, but not necessarily, given in metric unit such as grams per millilitre or grams per cubic centimetre. For comparison it may be noted that the specific gravity ($d^{t_2}_{t_1}$) of a substance is the ratio of the mass of a certain volume of the substance at temperature t_2 to the mass of an equal volume of a reference substance—normally water—at temperature t_1 and on this basis the specific gravity relative to water at 4°C (d^t_4) is equal to the density, expressed as grams per millilitre, at temperature t.] In general the density of the fluid is not the property required and it will therefore be apparent

* D. S. Muthukuda, M. T. Veerabangsa.

that the utility of commercially employed hydrometers, *e.g.* Brix spindles, battery hydrometers, formic acid hydrometers and metrolacs, etc., depends upon the constancy and reliability of the relationship between the density and the property required. In the case of the metrolac the required relationship is that between the density of latex and its dry rubber content. It might be appropriate at this point to make it quite clear that the fact that the standard glass metrolac is sold marked in lbs./gall. does not mean that this instrument is necessarily more reliable than one sold marked in more arbitrary units.

Figure 1.



The relationship between the density of latex and its d.r.c. may be calculated from a knowledge of the density of rubber and of serum. Typical average figures for these two quantities have been given by Fairfield Smith (4) and by van Gils (vide 1) and others, and the appropriate relationship is illustrated by the curve A B

of Fig. 1. Unfortunately, a commercially useful metrolac cannot normally be constructed on the basis of the calibration curve A B since much undiluted latex is too viscous to be used with standard type hydrometers and in any case there are in Ceylon many days when the latex is accidently diluted, *i.e.* during partial wash-outs or by damp cups and spouts, and others when much of the latex may be deliberately diluted by the tappers either with permission, *i.e.* for the addition of anti-coagulant, or without it. The unfortunate but necessary assumption that at weighing up latex is either likely to be or must be diluted with water complicates the relationship between the d.r.c. and the density. Thus, if A B of Fig. 1 represents the relationship between the density and the d.r.c. of latex coming undiluted from the tree then the density of mixtures of any given latex with water will be expected to lie upon the line joining the point on A B, corresponding to the given original latex, to the point W. The calibration table originally used in Malaya (Eaton's scale) with a hydrometer appears to have been based upon the behaviour of 'average' latex samples whose original per cent. d.r.c. is believed to have been about 35. This scale is represented in Fig. 1 by the line F W where F is the fixed or reference point. The scale fitted to the present Ceylon R.R.S. (O'Brien scale) glass metrolac is not identical to the scale employed with the brass metrolac. It will be apparent that a large number of metrolac calibration curves such as F_1W can be constructed on the basis of Fig. 1 (and limited preliminary experiments), although their utility might be strictly limited particularly if they fell outside the triangle LWL_1.

It is of special interest to examine the results obtained with latex samples whose original undiluted d.r.c. is different from that assumed in the calibration curve. For convenience, the calibration curve F_1W will be used as this corresponds very approximately to the O'Brien scale glass hydrometer. Thus, suppose the sample of undiluted latex represented by the point L on the line A B is diluted to give a density corresponding to the horizontal dotted line C C_1 then its true d.r.c. will be represented by the vertical dotted line C_1D, whereas the d.r.c. obtained by a metrolac, whose scale is based on the line F_1W, will be represented by the vertical dotted line E_1E which is equivalent to an overestimate of about 0.50 lbs. per gallon. Similarly, if a latex represented by the point F is diluted to the condition represented by the point G_1, it is apparent that the metrolac estimate of its d.r.c. will be underestimated by an amount represented by G-H on the rubber content axis. In general, therefore, when the d.r.c. of the original undiluted latex brought in by a tapper exceeds the d.r.c. of the undiluted 'standard' latex used to fix the scale of the metrolac, the total dry rubber brought in by the tapper will be expected to be overestimated by the metrolac; but, when the d.r.c. of the undiluted latex is lower than that of the standard, the tapper's output will be underestimated by the metrolac.

While it should be apparent that the metrolac can readily give misleading d.r.c. values, it must not be concluded that the early users of the metrolac were unaware of its limitations. Thus, diagrams similar to the one labelled Fig. 1 in this paper are to be found in much of the earlier literature (*e.g.* 4, 12, *et al*) and it seems probable that the metrolac was originally recommended as a control measure to allow latex to be diluted to a standard density (not per cent. d.r.c.) during manufacture rather than as a means of estimating the per cent. d.r.c. of tappers' latex. From a consideration of the theoretical aspects of this subject, Fairfield Smith (4) has pointed

out that, using the constants implied by the Eaton scale metrolac at 29°C, the ratio of the hydrometer assessment of the d.r.c. (in grams per millilitre) to the true assessment is:

$$1 + 3.06\,x - 8.84\,x^2 \qquad + \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where x is the difference (in grams per millilitre) between the d.r.c. of the undiluted latex from the tree and the d.r.c. corresponding to the fixed or reference point of the metrolac, *i.e.* 34.62 gms per 100 ml. When x is less than about .03, that is less than about 3 per cent. d.r.c., the formula suggests that the tapper's actual output of dry rubber will be over (or under) estimated by about 3 per cent. for every 1 per-cent. that the d.r.c. of the tapper's undiluted latex differs from the reference point of the metrolac. It will be apparent, therefore, that when dealing with a large number of clones whose average undiluted field d.r.c. values may range from, say, 30 per cent. to 40 per cent. the errors in total rubber output inflicted on whole groups of tappers might theoretically approach 15 to 20 per cent.

3. **Use of the Metrolac at Dartonfield.**—The descriptive matter in the previous section is intended to show in a simplified manner how and why errors in the estimation of the dry rubber content of latex can be expected to occur when the metrolac is used. The calculations of Fairfield Smith lead to the suggestion that in certain cases considerable numbers of tappers could quite easily have their dry rubber output over or underestimated by 15 to 20 per cent. Errors as large as 20 per cent. may actually be rather rare for figures averaged over long periods of time (vide Table No. 1), and it should be noted that the calculations leading to a numerical solution of the constants in equation (1) involve the assumption of fixed 'average' values for the density of serum and of rubber. However, it is known that the actual values of the density of serum and of rubber are not necessarily constant from latex to latex and van der Bie, for example, has quoted (1) figures of van Gils for the specific gravities at 30°C ranging from .9032 to .9052 for latex rubber and from 1.0131 to 1.0354 for latex serum. In terms of Fig. 1 this means that the extremities of A B cannot be regarded as subject to no uncertainty and are in fact only 'average' figures. Nevertheless, it appears to have been the opinion of some planters that the O'Brien scale glass metrolac is quite adequate for old seedling rubber. However, the volume and the nature of the inquiries received at the R.R.I.C. on the errors of the metrolac applied to Ceylon budded rubber latex together with the uncertainties and difficulties involved in applying the theoretical principles and constants mentioned above to normal commercial conditions suggested that the collection of new data on the errors associated with the use of the metrolac with (mainly) budded rubber latex might be worthwhile, especially if the data could be used for the comparative assessment of the errors of the metrolac and of alternative procedures. The experimental methods followed and the check tests carried out have been mentioned in the Annual Reports, (7, 8), where it will be seen that the errors of the metrolac have been identified with the difference (in lbs. of rubber/gallon of latex) between the d.r.c. obtained by trial coagulation and by the metrolac. A summary of much of the data is given in Table Nos. 1 and 2.

TABLE I

Task	Clone	Mean Metrolac 'Error' (59-60 readings)*	S. D. of 'Error'	Mean d.r.c. by coagulation	Mean of 2 Highest d.r.c. values
A	W 259	+ .28	.17	3.13	3.60
A	PB. 183	+ .27	.23	3.03	3.40
A	W 259 + HC. 28	+ .25	.20	3.14	3.60
A	AV 49	+ .23	.20	2.76	3.60
A	TJ. 1 + PB. 183	+ .23	.21	3.09	3.60
B	RRIM 506 +	+ .22	.29	3.21	3.60
A	HC. 28	+ .22	.22	3.13	3.60
A	AV. 49 + Rub. 393	+ .19	.24	2.84	3.50
A	TJ. 1	+ .16	.23	3.28	3.50
B	PB. 86	+ .15	.27	3.38	3.60
A	SR 9	+ .15	.24	3.08	3.60
B	Fraction Clones	+ .13	.24	3.11	3.60
B	PB. 86 + PB. 186	+ .10	.23	3.32	3.50
B	RRIM 520 + 514	+ .08	.30	3.36	3.40
B	Rub. 393	+ .03	.20	3.18	3.80
A	GL. 1 (N)	+ .02	.27	3.46	3.60
A	GL. 1 (R)	+ .02	.26	3.43	4.00
B	RRIM 500 + 501	— .04	.23	3.40	4.00
B	PB. 186	— .13	.22	3.35	3.70
B	PB 25	— .12	.24	3.54	3.80
B	PB. 25 (R)	— .24	.20	3.54	4.10
B	PB 25 (N)	— .24	.27	3.48	4.20
Mean		.09			4.20

[*d.r.c. by coagulation—d.r.c. by metrolac, units lbs. per gallon]

Examination of Table No. 1 suggests that for the 59 or 60 days of tapping involved the metrolac error ranged from an average of + .28 to — .24 lbs. of rubber per gallon of latex depending upon the tapping task involved at Dartonfield. The theoretical relationship between the d.r.c. of the original latex and the metrolac error is not reflected as strongly as might be expected in the relationship between the metrolac error and the mean d.r.c. or the mean of the 2 highest d.r.c. values of Table No. 1.

TABLE II

[Units lbs/gallon]

1. No. of Clones	10	9	9	11	10	11	10
2. No. of Tasks	11	11	9	13	13	13	13
3. No. of Days	41	40	40	19	19	29	30
4. No. of Readings	451	440	360	247	247	377	390
5. Dates of Tests	16-5-52–16-8-52	18-5-52–15-8-52	18-5-52–15-8-52	16-3-53–29-4-53	17-3-53–30-4-53	8-6-53–28-7-53	7-6-53–31-7-53
6. Mean Metrolac Error	.22	.12	.12	.10	.13	–.06	.08
7. S.Devn. Tasks	.12	.10	.11	.13	.21	.20	.21
8. S.Devn. Days	.13	.11	.11	.13	.15	.14	.14
9. S.Devn. Single Readings	.24	.23	—	.27	.30	.27	.29
10. Experiment No.	1	2	2A	3	4	5	6

The data summarised in the tables above refer only to particular tests carried out according to a fixed schedule with selected areas at fixed times and are not necessarily representative of other conditions. The data will include to a lesser or greater extent errors which are normal to this type. In the case of the metrolac readings it has been suggested elsewhere (9) that one major source of error can be the accuracy with which the latex subsample is diluted with water when this is necessary. Tests carried out at Dartonfield with eight different clonal latex samples each diluted (after subsampling) with water in a ratio of 1:2 suggested that even with only reasonable care the standard deviation of the metrolac reading of the ten subsamples per clonal latex sample need not exceed .04 lbs/gallon and that with a little more care the standard deviation can be almost indistinguishable from zero. While the variance corresponding to .04 lbs/gallon is not negligible, it is substantially less than the variance of the metrolac errors which can be found between clones and days and it has been tentatively concluded that while an error due to this source is probably present in the data summarised in the tables it is probably not systematic with reference to clones or tasks. In Estate practice it is obviously desirable to take reasonable care in the dilution (where this step is necessary), and simple calculation will indicate very approximately the order of the error to be expected under various conditions. Presumably relatively large vessels, which can be readily filled and emptied and into which one or more fingers or thumb do not have to be inserted for filling and for emptying, would be most suitable. A further source of error arises from the fact that the density of latex is not independent of the temperature, and in point of fact tappers who leave their latex in the sun would in general be expected to be credited with an unduly high rubber output. Fairfield Smith (4) has rather tentatively suggested that for the normal ranges of d.r.c. and Malayan temperatures the change in density per °C may be about .0004, *i.e.* slightly under .05 per cent. per °C, and that when working at a fixed dilution with different original latices the change in density per unit per cent. d.r.c. of the mixture is about .0012. On this basis an estimate of per cent. d.r.c. can be in error by .33 per °C deviation from the temperature for which the d.r.c. v density scale was designed; with latex diluted 1:2 with water the error, in the absence of a temperature correction, will be appropriately higher. In standard commercial practice is it not usual to make a correction for the temperature of the latex when this differs from the temperature for which the density v dry rubber content scale was designed. At many Estates errors due to this cause are accidently reduced due to the fact that a large proportion of the tappers often leave their latex in the shade at the weighing up centre while awaiting the arrival either of tappers from the more distant tasks or of the weighing-up officer. In the experiments summarised in this paper no correction has been applied for temperature variations as the data are intended to give information on the errors to be expected under conditions similar to normal Estate practice. Limited investigation of the temperature differences between the experimental tappers' latex just before sampling for d.r.c. determination at Dartonfield suggested that the errors in the metrolac readings due to this cause were likely to be neither very large nor systematic with respect to tasks or clones. However an appreciable part of the metrolac error attributed to between day effects may perhaps be due to temperature differences. It should be noted that on a commercial scale every reasonable precaution should be taken to prevent undue temperature differences between latex samples.

4. **Practical Implications, etc.**—The practical implications of the above data and certain other points are mentioned below under the relevant subheadings.

4.1. *Average Factory Excess:* If the average factory excess is defined by the term $(w—w_1)/1$, where w is the weight of (latex) rubber sold over a long period of time, w_1 is the corresponding weight of rubber brought in by the tappers as

estimated by the metrolac reading x the corresponding gallonage of the individual lots of latex and l is the total volume of latex involved, then there will be a tendency to equate the average factory excess to the mean error of the metrolac. In the case of Experiment Nos. 1 and 2 of Table No. 2 the average factory excess might be expected to amount to about 0.17 lbs/gallon, or, alternatively, if the metrolac reading of the latex at weighing up is 3.2 lbs/gallon the actual excess would be expected to amount to about 5.3 per cent. of the metrolac estimate of the total crop. For the period under examination at Dartonfield this estimate of the excess is not grossly in error, but this is probably largely fortuitous. Thus, if the volume of latex brought in daily by each individual tapper is 'l' gallons and its metrolac d.r.c. is 'm' with an error of 'e' lbs/gallon then the true total factory excess in lbs. 'X' is given by:

$$X = \sum_{1}^{n} [\,(m + e)\,l - ml\,]$$

so that if the tappers are numbered 1, 2, 3......to n

$$X = \sum_{1}^{n} (el) = e_1\,l_1 + e_2\,l_2 + \dots\dots\dots + e_n\,l_n \quad \dots\dots\dots\dots\dots\dots(2)$$

whereas the value of X_1, the excess in lbs. calculated from the (arithmetic) average metrolac error $\bar{e}^1$, is given by

$$X_1 = \bar{e}^1 \sum_{1}^{n} l = \bar{e}^1\,[\,l_1 + l_2 + \dots\dots\dots\dots\dots\dots + ln\,] \quad \dots\dots\dots\dots(3)$$

and the two estimates of the excess need not agree unless, for example, $e_1 = e_2 = e_3$ etc. or $l_1 = l_2 = l_3$ etc.

There are, therefore, three points to note at this stage. Firstly, the appearance of an average factory excess of zero or thereabouts does not necessarily mean that the metrolac is giving the correct reading for all the incoming latex samples; all that is implied is that the 'errors' balance in the sense of equation 2. Alternatively, the adjustment of the average factory excess to nearly zero by the addition or subtraction of a constant correction factor to or from the actual metrolac readings does not alter the accuracy of the instrument with respect to differences found between tasks, as may also be seen by reference to Column No. 3 of Table No. 1. This correction factor has been referred to elsewhere as the metrolac bias correction factor. Secondly, the factory excess need not remain constant over long periods of time, particularly if there is reason to suppose that the relative volumes of latex, the nature of serum from certain tasks or the number and type of the tasks are changing (vide 4.5 below). Thirdly, since the metrolac can show appreciably different average errors for different clones, proper allocation of any positive factory excess in lbs. of rubber is not easy without a prior knowledge of the nature of the errors. It may be appropriate to point out that even if the average factory excess is calculated using metrolac readings of the daily bulk, the relevant basic conclusions above are not necessarily materially altered, although the definitions of the terms w_1, $\bar{e}_1$, $\bar{e}$, e_1 ... e_n, l_1 ... l_n would have to be appropriately modified.

4.2. *Daily Factory Excess:* The average factory excess has been defined above, in terms of lbs. of rubber/gallon, as the metrolac error calculated over a long period of time and weighted according to the volumes of latex involved and it is convenient to consider the daily factory excess in the same terminology—the principle difference being that the number of readings is smaller. Thus equation 2 involving X, the total factory excess in lbs. of rubber, might still be written in the form:

$$X = e_1 l_1 + e_2 l_2 + \ldots\ldots\ldots\ldots + e_n^1 l_n^1$$
$$= \bar{e}_1 [l_1 + l_2 + \ldots\ldots\ldots\ldots + l_n^1]$$ and equation 3 in the form:
$$X^1 = \bar{e}^1{}_1 [l_1 + l_2 + \ldots\ldots\ldots l_n^1]$$ where $\bar{e}^1$ corresponds to the figure in Row No. 6 of Table No. 2

i.e. $$\bar{e}^1{}_1 = \frac{e_1 + e_2 + \ldots\ldots\ldots\ldots\ldots\ldots e_n^1}{n^1}$$ and

$$\bar{e}_1 = \frac{e_1 l_1 + e_2 l_2 + \ldots\ldots\ldots\ldots\ldots en^1 ln^1}{l_1 + l_2 + \ldots\ldots\ldots\ldots\ldots + ln^1}$$

It has been suggested in the Annual Report for 1952 (7) that by making a number of comparatively reasonable simplifications or assumptions it seems possible to show that the data, *e.g.* of Table No. 2, are in agreement with the view that metrolac readings can be made reasonably suitable for determining the approximate d.r.c. of the bulk of a large number of tappers' latex for purposes such as estimation of the weights of bisulphite, RPA. 3, etc. required for the bulk. One way to arrive at the estimate of the daily crop is to add up the estimated output of each tapper in which case the daily factory excess is governed by the value of $\bar{e}_1$. Unfortunately suitable information on the variation of $\bar{e}_1$ is not generally available as calculation of the actual factory outturn (sales and stocks in process) is not usually done on a daily basis. However information on the variations of e_1, e_2, etc. and of $\bar{e}^1{}_1$ are to be found in the two tables. It is therefore necessary to assume, for example, that the distribution of the values of $\bar{e}_1$ are normal with a standard deviation similar to that found for $\bar{e}^1{}_1$, cf the figures of Row No. 8 of Table No. 2. [In the special circumstances where $l_1 = l_2 = \ldots\ldots\ldots l_n^1$ or $e_1 = e_2, = \ldots\ldots\ldots e_n^1$, the values of $\bar{e}_1$ and $\bar{e}^1{}_1$ are identical and it is relevant to point out that there are cases where the volumes of latex brought in by the individual tappers are similar within days.] It will be apparent that the numerical value of daily factory excess, ($\bar{e}_1$ in lbs/gallon), will be lowest when a reliable correction has been applied to the metrolac, but as noted previously this need not necessarily affect the day to day variations around the mean figure. [A little thought will show that for the purpose of, say, addition of RPA. 3 the important figure is the daily variation of the factory excess about the mean not the mean itself. Thus, if the mean is not insignificant, the actual amount of RPA. 3 used after preliminary trials might appear to average, say, 10 ozs. per 1,000 lbs. of rubber in latex, whereas it is actually, say, 10.5 ozs.]

With a standard deviation of, say, .15 lbs. of rubber per gallon of latex as in Table No. 2, the daily factory excess, calculated as above, would be expected to be outside the limits ± .15 lbs/gallon about once in three days and outside the limits ± .30 lbs/gallon once in about twenty days. An error of .30 lbs/gallon on an average bulk d.r.c. of 3 lbs/gallon is only 10 per cent. in terms of the total dry rubber. It seems unlikely that an error of 10 per cent. will in all cases interfere very seriously with the use of bisulphite and RPA. 3 in the factory. However, should the error grossly exceed .30 lbs/gallon, as might occur with a metrolac, whose paper scale is showing appreciable undetected movement inside the stem, difficulties such as under or overbleaching of latex for crepe or bubbles, spongy or too hard coagulum in R.S.S. manufacture might occur. Therefore on the basis of the procedures and data outlined above it has been concluded that the data were in agreement with the view that, in general, metrolac readings can be made reasonably suitable for purposes such as the estimation of the weights of RPA. 3, bisulphite, etc. required for the bulk of latex.

In an alternative procedure the daily factory excess is obtained from metrolac readings of the bulk. When this procedure is followed, the basic conclusions that

the metrolac can be made reasonably suitable for the purposes such as the estimation of the weights of RPA. 3, bisulphite, etc. required for the bulk of latex would still be expected to hold.

4.3. *Average Yields of Tasks of Different Clones, etc.:* The difficulties involved in arriving at a reliable figure for the commercial yield of different clones is well known and at the organisations designed to ascertain the relative yields of different clones somewhat complex statistically designed field layouts are usually adopted. Nevertheless, certain Estates in Ceylon have planted relatively small areas of different clones presumably with the intention of ascertaining inter alia the performance of these clones under their own conditions. In many cases the latex or a suitably representative subsample is not coagulated separately and the metrolac is used to provide the estimate of the daily and hence the average annual yield, so that in addition to the normal errors and difficulties of this type of work there may be a further error due to the peculiarities of the metrolac. Much of the data of Table No. 2 can be applied directly to this problem under conditions where the size of the area of the individual clones corresponds to a single tapper's task.

Examination of the figures summarised in Table No. 2 shows that the numerical value of the errors of the metrolac (*i.e.* d.r.c. by trial coagulation—d.r.c. by metrolac) can differ significantly between clones as might be anticipated from Table No. 1. The standard deviation involved seems to vary from .1 to .2 lbs/gallon. This implies that the yield of one in three clones could be over or underestimated by at least about 31 or 62 lbs. per 1,000 pounds produced and that the yield of one in twenty clones could be over or underestimated by at least about 62 or 124 lbs per 1,000 lbs produced. How far these figures are truly representative of other clones, other areas, other tapping systems and other conditions etc. extended over longer periods of a year is not known. However it seems reasonable to suggest that isolated statements such as "I find Clone A gives 5 to 15 per cent. more rubber than Clone B" may have to be accepted with caution when it is known that the areas involved are not large and that the estimate of the yield is based on the use of the metrolac alone. As noted in connection with the discussion of the factory excess, allocation for yield purposes of a large part of any positive factory excess to selected tasks on the grounds, for example, that these give more latex per day need not necessarily be correct.

It will be apparent that the data summarised in Table Nos. 1 and 2 permit an approximate assessment of the degree of under or overpayment made to tappers in cases where the actual payment or a portion thereof is based upon the tappers' output. However the situation is complicated by the fact that in general the trees are usually tapped on a d/2 or d/3 basis whereas a tapper works officially on a d/1 basis, so that over or under payments will depend upon the weighted metrolac errors of 2 or more tasks. The figures reported elsewhere (7) seem to suggest that if the average tappers output is 1,000 lbs, then the output of one in three tappers can be over or under estimated by at least 50 lbs, one in twenty by at least 100 lbs and one in three hundred and seventy by at least 150 lbs. Again, how far these figures reflect what actually happens under different conditions as opposed to what can occur under the conditions of the experiment is not certain. However, it would appear desirable to bear in mind that certain groups of tappers can quite readily be overpaid (or underpaid) when dealing with a number of different clones; but, provided the metrolac is not inappropriately biased, the over or under payment will be expected to be at the expense of other tappers rather than at the expense of the Estate.

4.4. *Corrections for the Calculation of Daily or Annual Yields of Tasks of Different Clones:* Certain Estates realising the imperfections of the metrolac apparently

carry out check tests of the metrolac by determining at regular intervals, *e.g.* monthly, the tappers' output by means of a small scale trial coagulation and by means of the metrolac. Between the check tests a constant correction factor, whose numerical value depends upon the clone (or task) involved, would be applied to the metrolac estimate of the output. This procedure has not been applied recently on a clonal basis at Dartonfield but it is anticipated that, provided the check tests are carried out in a suitable manner, large differences in mean metrolac errors of the tasks might well be readily detected and at least partially eliminated. The reliability of this procedure will be expected to depend very largely upon the time interval between the batches of check tests and upon the number of check tests made per task, as the metrolac error for a particular task can vary between days and the mean metrolac error for the clonal task may show seasonal drifts. Possibly calculation of a correction factor from the mean error found on three or four consecutive tapping days at the beginning of each month may be suitable, but for the highest accuracy it is obviously desirable to rely solely on a daily small scale trial coagulation procedure. The use of a correction based upon checking the metrolac in the manner described in p. 43 of the 2nd Edition (1943) of 'The Preparation of Plantation Rubber in Ceylon' (*e.g.* by drawing two one gallon lots of a bulk once per month and comparing the weight of dried rubber obtained with the metrolac figure) does not serve to eliminate errors due to differences between clones or tasks. However, the correction factor obtained by repeating this test on a number of days could under certain circumstances serve to bring the factory excess to nearer zero when this is desired; but it might be just as easy to use a factor calculated from the previous month's factory excess. Where the object is to check the metrolac for errors due to scale slippage (or wear), the remarks in Subsection 4.6 apply.

It is understood that limited numbers of Estates have contemplated carrying out periodic estimations of output using only a small scale trial coagulation procedure at rather irregular intervals. While this subject is not strictly relevant to this paper it will, of course, be noted that this procedure, which does not envisage any checking with the metrolac at all, will not necessarily serve to prevent gross dilution of the latex by the tappers. A procedure of this type has been employed by the Botany Department of the R.R.I.C. on a bi-monthly basis to arrive by calculation at the comparative yields of different clones for, say, one hundred and forty tappings. How far this figure reflects the true commercial yield per year can depend upon the nature of the variation of the dry rubber output of the area between days, months, seasons, etc. and upon the distribution of the days of sampling with respect to these variations.

4.5. *Sale of Latex:* A number of Estates in Ceylon sell or have sold lightly preserved latex or coagulum to other Estates or to concentrated latex manufacturers, payment being made either on the basis of the estimate of the rubber in the latex or after weighing of the rubber produced from the latex or coagulum. In cases where the payment is made on the basis of the rubber in the latex many Estates still tend to base their estimates on the tappers' output derived from individual metrolac figures. When disputes concerning payments occur, these Estates tend to quote (if appropriate) a comparison of their present with their earlier factory excess figures. While this subject with reference to sales to concentrate manufacturers is briefly mentioned in Subsection 2.3 of the Chemical Department's Annual Report for 1954 and may be discussed elsewhere in more detail, it seems appropriate to mention here certain further points concerning the use of the factory excess.

On the basis mentioned in previous paragraphs the true factory excess in lbs, X, has been defined (equation 2) by the simple expression

$$X = e_1 l_1 + e_2 l_2 \ldots\ldots\ldots\ldots + en\, ln$$

where e_1, e_2, en are the metrolac errors for tasks, 1, 2, n giving l_1, l_2 and ln gallons

of latex respectively. It is known that l, the volume of latex obtained by a tapper from a task, is not invariably constant between days and in general more crop is obtained towards the end of the year than is obtained, for example, shortly after wintering. Similarly, the data summarised in this paper and elsewhere imply that the metrolac error can vary between clones and between days, and on theoretical grounds a variation attributable to changes in depths of tapping (3) and possibly to changes in tapping systems, [in so far that these might appropriately modify either the d.r.c. of the original latex or the composition of the serum], may be anticipated. At the same time a change of metrolac due to breakage or a change in operators may not be without influence on the factory excess. While certain Estates claim that their factory excess remains reasonably constant, particularly if due note is taken of the period of the year, it should be apparent that in view of the large number of factors involved a prediction of the actual factory excess can only be accepted by a latex buyer as a rough guide, especially if the buyer has no information concerning the volume of latex from newly tapped clearings, changes in tapping systems and the care with which the metrolac is used etc. While the excess calculated from the arithmetic average metrolac error, $\bar{e}_r$, is not necessarily identical to the true excess, it will be noted (Table No. 2 Row No. 6) that the arithmetic average metrolac error is not invariably constant and that information in the literature suggests marked seasonal variations in serum composition. While prediction of the actual factory excess, over not too short periods of time, on the basis of previous data may have to be accepted with reserve, prediction of the excess on a daily basis will be even more difficult due to the variation of the average metrolac error between days. Therefore, if the estimate of the dry rubber content of latex sold outside the Estate is based solely on the use of the metrolac as described above rather than on more accurate methods, it may be desirable, when investigating a suspected shortage, to consider not only the shortage found on a single day but also the average figure over a longer period of time.

In the preceeding paragraph the factory excess has been considered in terms of the sum of the tappers' output, but, for the purpose of sales of latex, the dry rubber content may in certain cases be calculated from metrolac readings of subsamples of the homogenised bulk taken before the addition of large amounts of ammonia or of other latex anticoagulant, and it seems relevant to make it clear that here also the constancy of the factory excess should not invariably be assumed.

4.6. *Checking Metrolacs for Scale Errors, etc. Adulteration of Latex:* For the purpose of deciding whether a metrolac is giving grossly erroneous information as a result, for example, of a misplaced scale, Estates often compare the d.r.c. obtained by trial coagulation with the figure obtained by the metrolac. This is only relatively simple to carry out as it usually requires proper care in the dilution of the latex and in the matter of temperature control; in addition the test should be repeated a considerable number of times with different initial latex samples. Thus, for the data summarised in Table No. 2 the standard deviation of the error of a single metrolac reading on a single latex sample is about .23 to .30 lbs/gallon, implying that out of every three random latex samples tested and (belonging to the population described in the table) one will be expected to show on an average an apparent metrolac error which is in effect unreliable to at least $\pm$ .23 lbs/gallon. Under many circumstances, therefore, it is easier and sufficient to compare an 'unknown' metrolac with a reliable metrolac using for both metrolacs the same subsamples of latex. The 'unknown' and 'known' metrolacs should be compared over the range of d.r.c. values likely to be encountered in normal use. New glass metrolacs should always be tested to ensure that the scale is not incorrectly located inside the stem.

The addition of soluble or dispersible substances, *e.g.* latex anticoagulants or adulterants, can interfere with the use of the metrolac under certain conditions. In

general, metrolacs are not recommended for use with ammoniated latex but it seems likely that the term ammoniated latex needs more careful definition in the literature in this context. As far as is known the metrolac is used in Ceylon with lightly ammoniated latex, where the ammonia content is not much above .02 per cent. on the latex. Tests, whereby latex taken from five different tasks on four consecutive tapping days was ammoniated using 10 per cent. solution to 0 per cent., .05 per cent. and .1 per cent, showed slight but statistically insignificant differences in the metrolac d.r.c. when the value was determined about one hour after ammoniation. Where the ammonia content is higher or the time of contact (with the latex) before estimation of the d.r.c. longer, the metrolac may be unsuitable for even approximate determinations of the d.r.c. However, many of the samples providing the data summarised in Table No. 2 contained the usual small amounts of latex anticoagulants. The addition of tapioca flour or cunjee is stated to have the effect of lowering the metrolac reading rather than raising it, although the d.r.c. obtained by coagulation may well be increased by the presence of these adulterants.

4.7. *Yields of Monoclonal Tasks:* Subsections 4.3 and 4.4 above deal with latex from tasks of different clones and this Subsection will deal with tasks from monoclonal areas. Differences in metrolac errors between tasks of different clones is readily comprehended on the basis of the theoretical principles underlying the subject. However, it is rather more difficult to understand why appreciable differences between tasks of a single clone should be expected to occur and van der Bie (1) appears to have taken the view that with an area planted with 'trees of equal quality' in a soil of 'uniform quality' the latex per day will possess an invariable composition. While the exact definition of the term 'trees of equal quality' is not entirely clear, a slightly different standpoint has been taken by Fairfield Smith (4) who has quoted the data of Rhodes *et al* to suggest that for tasks of similar trees the standard deviations of the d.r.c. between tasks may be about .7 to 1.4. On the basis of equation 1 this implies a difference in metrolac error between tasks and it seems likely that certain earlier writers also took this view. More recently information suggesting that certain of the the mineral components of latex are not independent of the clone, the season nor of the fertiliser has been advanced, implying that latex composition is not necessarily independent of the soil status and hence of the individual tasks. Further, recent studies in the electrophoretic mobility of fresh latex seems to suggest measurable differences, in the nature of the particle surface, between clones and between trees within a clone and possibly between days for a tree. Whether the differences in mineral composition referred to above are sufficient to cause appreciable changes in the density of the latex at a substantially constant d.r.c. is not entirely clear and various tests to determine the nature of the metrolac errors within clones have been put in hand.

Unfortunately, large monoclonal areas are not available on the R.R.I.C. lands and this subject has therefore been studied by splitting normal tappers' tasks into subtasks on the basis of 3 Tasks each of 1 Clone x 3 Subtasks x Days. One experiment was carried out at Nivitigalakele and a second with different clones at Dartonfield. In both experiments the variances due to Clones, Subtasks and Days are significant in comparison with the interactions Clones x Days (which is the usual error) and Subtasks x Days; but in one experiment the variances due to Clones and Subtasks are not significant in comparison with their interaction. Tentatively, the conclusion drawn is that the metrolac error can vary significantly between subtasks of a single clone, and that where the significance of the variability of subtasks against the interaction Clones x Subtasks is not established, the latter is itself highly significant and suggests that marked differences between the behaviour of subtasks of different clones may be found. There is some evidence within the data that the less conclusive experiment was not carried out with adequate care, but the

principal conclusion that the errors of the metrolac can sometimes show marked variations within subtasks of at least certain clones seems to be established.

On the basis of this data any suggestions that the differences in metrolac errors between tasks of one clone are negligible may have to be accepted with caution.

5. **Summarising Discussion and Comments.**—The Eaton (Malayan) scale metrolac, for example, is based (4) on the change in density at 29°C produced by the addition of water to an average latex of initial d.r.c. equal to 34.62 gms. per 100 ml. and of density equal to .9753. The order of errors likely to be found with latices whose initial d.r.c. is greater or less than 34.62 gms. per 100 ml. (the reference point) is illustrated pictorially in Figure No. 1, where it is assumed that A B represents the relation between the density and the original undiluted d.r.c. of these samples of latex. Thus, on the assumption that the components of latex mix without appreciable chemical interaction, latex samples, which can be represented on A B and whose initial original d.r.c. exceeds the reference point of the metrolac, will be expected to show erroneously high metrolac d.r.c. figures, and conversely when the original undiluted d.r.c. of a latex sample is low the value of the d.r.c. obtained by the metrolac will be expected to be lower than the true value obtained by coagulation. Cases where, for example, the original d.r.c. of 34.62 gms. per 100 ml. may not correspond to a density equal at 29°C to .9753 are not mentioned in Figure No. 1 and can be regarded as cases where either A or B or both in A B should be represented by different points at a time when the metrolac calibration line remains substantially as shown in Figure No. 1. Calculation leads to the conclusion that comparatively small variations in the density of the original serum can produce an appreciable effect on the reading likely to be found with the metrolac, so that the basic generalisations that (*a*) at a d.r.c. corresponding to that used to construct the scale of the instruments correct answers will be found and that (*b*) with high initial d.r.c. values the metrolac will be expected to give a high value, etc. have to be accepted with caution. This need for caution is borne out to some extent by the data in Table No. 1 and one principal object of the experiments was to ascertain how far these variables would influence the relationship between the d.r.c. obtained by coagulation and by the metrolac under conditions similar to normal Estate practice using budded rubber latex. Some of the practical implications of the theoretical principles and of the data as well as certain other matters are discussed in Section 4.

Regarding the use of the metrolac under normal commercial conditions, that is with latex which may contain unknown amounts of water added in the field, it is usually considered difficult to see how the accuracy of standard metrolacs can be substantially improved, provided (*a*) at least reasonable care is taken during any dilution stage, (*b*) errors due to temperature differences are reduced (as far as reasonably practicable) between latex samples within days if not between days and provided (*c*) reasonable care is taken to ensure that the scales of new metrolacs are not in error and that these are checked at suitable intervals. The suitability of a metrolac for any particular purpose depends upon the inherent accuracy of the metrolac for the purpose involved and upon the order of error permissible. Thus, there seems to be little doubt that, in general, the metrolac can and should detect many cases of gross dilution of latex in the field by the tappers and the instrument still serves as a psychological weapon to prevent such gross dilution by the tappers with, for example, poor quality water. Similarly, in general, the metrolac can be made reasonably suitable for the purpose of standardisation of latex prior to the addition of bisulphite, RPA. 3; but, where it is necessary to obtain an accurate estimate of the output of each task or tapper or where it is necessary to arrive at a reliable estimate of the rubber content of a bulk of latex the metrolac cannot invariably be used with complete or sufficient confidence. Application of appropriate correction factors to certain tasks or groups

of tasks which are known to have their yields grossly over or underestimated may well reduce the overall average error for these tasks but does not necessarily eliminate errors between individual tappers within these groups of tasks or between days.

For the more accurate work the simple and reliable method of estimating the dry rubber content is coagulation of a representative subsample (10, 11). The size of the subsample and the procedure adopted will depend upon the quantity of material and apparatus or equipment available as well as upon the accuracy required. For the highest accuracy a procedure similar to that suggested by the British Standards Institution for ammoniated latex (2) is suggested (5). Where facilities for this type of work are not usually available but where there is ample raw material, such as in the estimation of the d.r.c. of bulks of freshly preserved latex sold to concentrate manufacturers, it seems to be possible to coagulate relatively large but representative subsamples (*e.g.* of the order of 1 to 2 or more gallons) and to weigh the resulting rubber on less precise scales. This subject may be referred to in a later paper in this series. Where the accuracy need not be of quite such a high order and where the volume of the material is strictly limited a procedure of the type mentioned in the appendix and in the second supplement to Advisory Circular No. 17 (Trial Coagulation) may be convenient. This procedure can probably be made suitable for the estimation of the d.r.c. of tappers' latex in cases where the metrolac may not be sufficiently reliable, as, for example, in the comparison of the yields of certain new clones or of certain experimental type areas or when the system of payment of tappers requires accuracy beyond that usually obtained with the metrolac. As far as is known, many Estates in Malaya and Indonesia carry out daily small scale trial coagulations of the tappers' output and there may well be a case for following this procedure under certain circumstances in Ceylon. These small scale trial coagulations can result in a slightly higher (say .1 to .3 per cent.) scrap figure and are rather more laborious than using a metrolac. The objection of daily weighing of the piece of dry rubber ($\frac{1}{4}$-$\frac{3}{4}$ ozs.) obtained from the coagulated subsample can be met by a suitable modification of the aliquot sampling procedure. The principles of this procedure and its application are mentioned in the appendix and elsewhere. Where the accuracy need not approach the order expected from a carefully executed daily trial coagulation (50 or 100 ml.), the procedure, whereby a metrolac correction factor for the month is calculated from trial coagulation and metrolac d.r.c. values on, for example, three or four consecutive tapping days near the beginning of the month, may under certain circumstances serve to reduce gross differences of metrolac errors between the tasks tested. However this procedure has not been investigated extensively for a large number of clones. Alternatively, the procedure of estimating the comparative yields of tasks on the basis of two or more trial coagulation determinations of the d.r.c. per month may be suitable in certain cases. However it will be noted that the latter procedure alone need not prevent gross dilution in the field, gives a calculated rather than a commercial annual yield figure (Subsection 4.4) and may require the tasks which are to be compared to be tapped on the same days.

6. **Summary.**—This paper deals primarily with the use and abuse of the metrolac under normal Estate conditions and is intended to remind users that the metrolac is not, and was probably never expected to be, an accurate instrument. Using experimental data obtained with the metrolac, an attempt has been made to illustrate some of the conditions where the metrolac probably can and cannot be employed with reasonable confidence.

7. **Acknowledgements.**—Acknowledgement is made to the Botanist R.R.I.C. and to the former Superintendent, Mr. G. W. D. Barnet, for early information on

various points of Ceylon practice. Acknowledgement is also made to the Experimental Staff attached to Estate Dept. R.R.I.C. who collected a large part, but not all, of the experimental data.

8. **Appendix.**—(*a*) *Trial coagulation:* When there is reason to believe that the metrolac estimate of, for example, the dry rubber content of tappers' latex from certain tasks is not sufficiently accurate and where a very high degree of accuracy is not essential the following procedure or a suitable variant thereof can usually be adopted.

Stir the latex to be sampled and (after straining) measure off 50 ml. into a latex cup or dish. Wash out the cylinder or vessel used for the measurement with about 30 ml. of clean water and add this diluted latex to the dish, which should be marked with the tapper's name or number. For coagulation and milling the same day, add about 20 ml. of 1 per cent. acetic acid (10 ml. of concentrated 98 to 100 per cent. acid diluted, with mild agitation, to 1,000 ml. with water gives approximately 1 per-cent acetic acid) and stir with a small paddle or rod to mix the latex and acid. Pour a little water down the stirrer when it is removed from the mixture or shake well inside the dish. Where the milling is to be carried out on the following morning 13 ml. of acid is usually sufficient, but the quantities of acid should in all cases be adjusted for proper coagulation under the conditions involved.

At the end of the appropriate interval for coagulation, the sample is milled as thin as possible (with water) using preferably a smooth sheet mill or a smooth crepe mill and placed in the crepe tower (or smoke-house or left to dry in the air). With an efficient crepe tower and a thin sheet, the sample may dry overnight. At the end of the drying the sample is weighed on a balance accurate to preferably .1 gms. or less and the weight found, in grams and decimals of a gram, divided by 5 (strictly 4.989) is the dry rubber content of the latex in pounds and decimals of a pound per gallon. [Alternative units may be more convenient and if 2 fluid ounces (British) of latex are taken then the weight of rubber in scruples (and decimals of a scruple) multiplied by 0.228 is the d.r.c. in lbs per gallon or when this rubber is weighed in grams, this weight divided by 5.67 is the d.r.c. in lbs. per gallon.]

(*b*) *Aliquot Sampling Modification:* One objection to the above mentioned procedure is the necessity of weighing rather carefully each day small amounts of dried rubber from the subsamples. This is rather lengthy and requires, for preference, a balance accurate to about .1 grams. One Superintendent (Mr. G. W. Aldridge) suggested that the procedures would be simplified if the biscuits were milled, dried and weighed only once a week or once a month, when the weight of dry rubber, in grams, divided by 5 and by the number of days involved would give the average d.r.c. for the period. This procedure can only be applied under special circumstances such as when the daily volume of latex from a particular task under consideration is constant; however, this difficulty can be overcome by sampling the tasks concerned on a proportional basis, such as 2 millilitres per pint or per pound or as convenient. A procedure which might be adopted is described below:—

If it is desired to calculate the yield of a particular task on a monthly basis only, each time that the task is tapped the volume of latex involved is measured accurately, say, in pints and half pints (or in other suitable units) and a subsample on the basis of 2 ml. per pint is measured off, coagulated, milled and dried in the manner described under trial coagulation. After drying the sample of dried rubber is hung on a labelled spike in a locked cupboard, successive samples from the same task obtained by the same procedure being hung on the same spike. At the end of the month all the rubber is weighed together on a scale which can, for preference, give the weight

accurate to 1 per cent. or better. If the sampling is on the basis of 2 ml. per pint of latex then the total dry rubber (in pounds) obtained from the task will be approximately equal to the total weight of the subsamples of dry rubber divided by 1.6, provided that the latter weight is in terms of grams and decimals of a gram. If the task concerned is tapped twelve times per month and yields an average of four gallons per tapping at about three pounds per gallon the total weight of the dried rubber subsamples will be about 8 ozs. so that scales accurate to 1 to 2 grams should be adequate.

The main practical objection to this procedure is that the effect of an error in measurement of a single latex subsample cannot be overcome by calculation of a more accurate figure. Nevertheless, while the aliquot sampling technique has not been applied over intervals as large as a month between final weighing, it has been used experimentally for periods of five to six tapping days. Fuller details which suggest that the procedure can be considerably more reliable than the use of the metrolac are to be found elsewhere (7, 8).

LITERATURE

1. van der Bie, G. J., Chronica Naturae 1947 103 36 (ex R.R.I.M. and Singapore Translation Brueau).
2. British Standards Institution, B.S. 1672 Part I; 1950: p. 8-9.
3. Eaton, B., Fullerton, R. G., Quart. J. Rubb. Res. Inst. Malaya 1929 **1** p. 132-134.
4. Fairfield Smith, H., J. Rubb. Res. Inst. Malaya 1947 **12** p. 47-61 (Comm. No. 263).
5. Risdon, E. J., R.R.I.C. Quart. Circs. 1952 **28** 1-2 p. 3-6.
6. Risdon, E. J., R.R.I.C. Quart. Circs. 1952 **28** 1-2 p. 7-14.
7. Risdon, E. J., Ann. Repts. R.R.B. Ceylon 1952 p. 11-14.
8. Risdon, E. J., Ann. Repts. R.R.B. Ceylon 1953 p. 11-13.
9. R.R.I.M., Chem. Divn. Ann. Rept. 1951 p. 18-19.
10. R.R.I.M., Leaflet C/M 34 (49).
11. de Vries, O., 'Estate Rubber' 1920 p. 108.
12. de Vries, O., Archief 1919 p. 192.

Received March, 1955.

THE DETERMINATION OF THE DRY RUBBER CONTENT OF NATURAL RUBBER LATEX. PART IV—USE OF THE TOTAL SOLIDS DETERMINATION

BY

E. J. Risdon and the Staff of the Chemical Dept.*

1. **Introduction.**—Previous papers in this series mention (3, 4) some of the methods used for the accurate determination of the per cent. d.r.c. of subsamples of fresh and of freshly preserved latex, *e.g.* subsamples of bulks of latex sold to latex concentrate manufacturers. In commercial practice in Ceylon these methods have certain obvious objections. Thus, the basic minimum equipment requirements of an accurate balance or scales with preferably an oven at 70°C are not generally available at present on small and medium sized Estates. As mentioned elsewhere (5), these Estates might prefer to determine the d.r.c. of their latex bulks with fair accuracy (for routine check purposes) by the use of subsamples of larger size, *e.g.* one to two or more gallons, and less accurate scales. Latex buyers may also find the official methods objectionable on the grounds of the long time interval between the commencement and the completion of the tests.

From time to time various authors have suggested (2 *et al*) that the per cent. d.r.c. might for convenience be calculated from the per cent. total solids (per cent. t.s.) by means of an equation of the type, per cent. d.r.c. = K x per cent. t.s., where by analogy to other agricultural industries, *e.g.* the sugar industry, K might be referred to rather loosely as the quotient of purity (Q.P.). The total solids determination, as approved by the British Standards Institution (1), is comparatively rapid and involves no washing or milling of coagulum, merely a period of drying the latex at a specified temperature (98-100°C). Since evidence was at one time available to suggest that certain latex buyers contemplated using the per cent. total solids to estimate the per cent. d.r.c. of incoming lots of freshly preserved latex by means of the equation, per cent. d.r.c. = K x per cent. t.s., various tests have been carried out to ascertain whether K may be regarded as constant under the appropriate circumstances. If the procedure can be employed for normal latex it might be of interest in preference to trial coagulation for the determination of the d.r.c. of tapper's latex or perhaps, more suitably, for the determination of total daily input to the factory from individual Divisions, especially if an apparatus incorporating its own heating unit, *e.g.* infra red lamp, and reading directly in terms of per cent. total solids or per cent. dry rubber content could be employed.

2. **Methods of Investigation and Discussion.**—While the relationship between per cent. t.s. and per cent. d.r.c. has been considered primarily in the form, per cent. d.r.c. = K x per cent. t.s., alternative relationships might actually be more suitable and a relationship of the form, Δ = per cent. t.s.—per cent. d.r.c. = A — Ax per cent. t.s., has been suggested in London. Both these relationships have been examined and it seems appropriate to consider their implications. Thus, if normal latex may be treated as a non-homogeneous mixture of water, of rubber (R) and of organic and inorganic serum constituents of which only a part (SS) is involatile at

* D. S. Muthukuda, M. T. Veerabangsa, G. G. Gnanasegaram.

the total solids drying temperature and of which the remainder (V) is volatile or seriously decomposed, and if the fractions of the above serum constituents retained to count as rubber in the per cent. d.r.c. estimation are Y and Y^{1}, then assuming that the effects of any thermal degradation of the rubber are small, K may be written as:

$$K = \frac{R + Y \times SS + Y^{1} \times V}{R + SS}$$

If the fractions Y and Y^{1} are such that the proportion of serum substances counted as rubber in the per cent. d.r.c. estimation is a constant fraction of the dry rubber for normal latex with a fixed test procedure, then:

$$K = \frac{R\,(1 + C)}{R + SS} \text{ where C is a constant}$$

Thus, if K is to be substantially constant irrespective of the normal latex involved it would then be necessary for SS to be either small in comparison with R or a constant fraction of R under all normal circumstances. Although part of the inorganic serum solids of latex is not necessarily constant between latex samples or between seasons, there is a distinct possibility that K might be sufficiently constant for normal latex samples for at least certain purposes. It is worth noting that where R is larger or the serum solids relatively smaller, as might be found with purified or some concentrated latices, the constancy of K might be anticipated with greater confidence.

A relationship involving Δ, the difference between the per cent. t.s. and the per cent. d.r.c., may be deduced in several ways depending upon the assumptions made. Thus, if the concentration of serum solids in serum is assumed to be constant, hence in the above terminology:

$$\frac{SS}{1-(t.s.-SS-V)} = C^{1}$$

$$\begin{aligned}
\text{then}\,\Delta &= R + SS - (R + Y \times SS + Y^{1} \times V) \\
&= R + SS - R\,(1 + C) \\
&= SS - RC \\
&= C^{1}/(1 - C^{1}) - C^{1} \times t.s/(1 - C^{1}) + C^{1}V/(1-C^{1}) - RC
\end{aligned}$$

If the last two terms can be ignored, a graph of Δ against per cent. total solids should show a straight line with a slope of $-\,C^{1}/(1-C^{1})$. However, there are some grounds for doubting whether the last two terms can be ignored and whether C^{1} will be a constant under all circumstances. The value of this graphical method as a means of computing the per cent. d.r.c. accurately is therefore likely to be questionable.

In more practical terms, if the per cent. t.s. is employed to calculate the per cent. d.r.c. of freshly preserved latex accurately, the value of K should preferably meet the following requirements:—(*a*) K should be substantially, if not entirely, independent of daily variations in the bulks of latex being supplied by the single Division or Estate involved in the sale. It would obviously simplify matters if K is constant irrespective of the Divisions or Estates involved as well as of the days; (*b*) K should be independent of variations in the ammonia contents of the bulks, implying that if the per cent. ammonia in the latex changes accidently or by design K will remain unaffected and (*c*) K should preferably be independent, within reasonably wide limits, of the intervals between the ammoniation and the testing of the latex. In the initial texts six samples of latex all drawn on different days from either a budded yellow latex bulk or a white old seedling bulk have been examined prior to ammoniation and again (with sludge dispersion by swirling) at one, twenty four and seventy

two hours after ammoniation to .5 per cent. and .7 per cent. (on the weight of latex) using concentrated ammonia solution. [In all cases K is the mean of two or more per cent. d. r. c. determinations divided by the mean of two or more per cent. t.s. determinations]. Much of the relevant data is summarised in Table No. I which shows marked differences in the K values of the different original latex bulks, *i.e.* the true per cent. d.r.c. ranges from 88.5 to 93.4 per cent. of the true per cent. t.s. Detailed statistical examination of the data shows highly significant differences between mean K values for the six samples and suggests significant differences both within and between types of latex samples (*e.g.* white and yellow bulks). The latter has been shown to be attributable in part at least to variations between days of sampling of the bulks, implying that the average K values for bulked latex samples drawn from a particular group of tasks can show significant daily variations.

TABLE I

Latex Type	Day No.	Value of K Fresh Latex	Mean Ammon. Latex
Yellow	1	.914	.913
Yellow	2	.930	.930
Yellow	3	.934	.930
White	1	.905	.904
White	2	.907	.902
White	3	.885	.892

Variations in K due to differences in the two ammonia concentrations used for the preserved latex are not found to be significant as the different samples of latex appear to behave differently with the two ammonia concentrations. The differences in K values between times of test after ammoniation appear to be significant, the highest values being found seventy two hours after ammoniation. Here again there is significant evidence that all the samples have not behaved in a similar manner; this is tentatively interpreted to imply that the high values of K at seventy two hours after ammoniation may be the result of sludge formation which, depending upon the latex involved as well as upon the degree of homogenisation before subsampling and the efficiency of milling, may be expected to contribute to the per cent. t.s. figures but only partially to the per cent. d.r.c. figures. In this connection an earlier paper in this series (4) clearly suggested that under the experimental conditions employed the apparent decrease in per cent. d.r.c. of ammoniated latex sometimes found over short periods of storage need not necessarily be either numerically large or statistically significant. In some of these tests also the variance due to 'times of storage x samples of latex' has been shown to be statistically significant in comparison with the variance due to the second order interaction 'times of storage x samples x replicates' and in comparison with the variance due to 'replicates, within samples and times of storage'.

The criteria suggested in the first paragraph of this Section for the use of K in the accurate calculation of per cent. d.r.c. from per cent. t.s. are not entirely fulfilled by the data partially summarised in Table No. I. Thus K is not necessarily independent of the interval between ammoniation and testing, the simplification that for convenience K should be constant irrespective of the bulk involved (*i.e.* irrespective of days and of Divisions or Estates) does not hold and the data also suggest that the

TABLE II

Clones	K Value of Day No. I	II	III	IV	V	VI	VII	Total	Mean
RRI. 500 + RRI. 501	.8848	.8728	.8999	.8809	.8689	.8741	.8617	6.1431	.87758
RRI. 520 + RRI. 514	.8873	.8673	.8940	.8693	.8775	.8253	.8638	6.0845	.86921
RRI. 506 + Stock Seedling	.8801	.8670	.8984	.8636	.8765	.8269	.8537	6.0662	.86660
PB. 186	.8768	.8784	.9044	.8711	.8689	.8737	.8789	6.1522	.87886
PB. 25 + AV. 256	.8879	.8826	.8853	.9235	.8778	.8642	.8267	6.1480	.87828
PB. 25 + AV. 256	.8639	.8748	.9043	.8944	.8729	.8821	.8552	6.1476	.87823
Total	5.2808	5.2429	5.3863	5.3028	5.2425	5.1463	5.1400	36.7416	
Mean	.88013	.87381	.89772	.88380	.87375	.85772	.85667		.87480

average K values of latex from a particular group of tasks can show marked daily variations. Further information on the latter point has been sought by a consideration of the daily variations of K values for certain fixed clonal tasks, and fresh latex from six tapping tasks has been tested for per cent. d.r.c. and per cent. t.s. on seven almost consecutive tapping days shortly before a wintering season. A summary of the data is given in Table No. II with a provisional analysis of variance in Table No. III.

TABLE III

Source of Variance	Deg. of Freedom	Variance	F(T x D)
Between Tasks (T)	5	.00020552	.877 - -
Between Days (D)	6	.00125735	5.363**
T x D	30	.00023445	—

Examination of Table Nos. II and III suggest that the variations in average K values of the individual tasks involved are not significant in comparison with the first order interaction, but that the variations in (arithmetic rather than weighted) K values of all the tasks show significant variations from day to day. The standard deviation of average K values between days is about .0145. Depending upon the per cent d.r.c. and the average K value, this standard deviation might correspond to about 1.65 lbs per 100 lbs of rubber involved and a figure of this order is at present considered to be rather high for the accurate calculation of the (daily) per cent. d.r.c. of latex. [In the same terminology the standard deviation of individual (single) estimates of the per cent. d.r.c. of a sample of latex can be equivalent to about .12 lbs/100 lbs total rubber involved, although with less careful operators the figures may approach .45 lbs/100 lbs. These figures refer to data mentioned in literature reference number 4]. On the basis of the evidence of the rather restricted data summarised in this Section, the tentative conclusion drawn is that the calculation of the per cent. d.r.c. of samples of latex from the observed per cent. t.s. by means of a correction factor as described will not necessarily give an accurate estimate of the daily per cent. d.r.c., primarily because the factor can vary between latex samples, etc. (Table No. I) and between days (Table No. II). The method might, of course, be applicable to the latex from certain specified and constant areas once the necessary basic information on the average K value and on the daily and seasonal variations or drifts in K are known for the area concerned; but, lacking such information, the use of the procedure seems hardly justified for the highest accuracy. Thus, if an Estate sells the latex from certain fixed tasks only, small daily variations in K need not necessarily be of great consequence provided these errors balance out over longer periods of time in the sense that the total rubber delivered is not inaccurately estimated. [However, an error of — .3 per cent. in the per cent. d.r.c. in one week is not necessarily balanced out by an error of + .3 per cent. in the next week, unless, for example, the actual total dry rubber involved is equal in both cases. Similarly, it might perhaps be difficult in practice to balance out errors due to any seasonal drifts in K values or to changes in the tasks involved in the deliveries.]

The procedure might be suitable for a less accurate determination of the total rubber intake of the factory or from a certain Division, but a trial coagulation of

relatively large subsamples, *e.g.* one to two or more gallons, is for many purposes sufficiently easy to perform and sufficiently accurate.

The suggestion that the per cent. d.r.c. might be calculated graphically from a relationship of the form Δ = A-Ax per cent. t.s., where Δ is the difference, per-cent. t.s.—per cent. d.r.c., has been mentioned previously. The data in Table No. II have been examined on this basis by plotting against per cent t.s., and the tentative conclusion drawn is that this relationship is not necessarily likely to be suitable as very similar values for the per cent. t.s. readily give grossly dissimilar values of Δ even with latex from the same original task.

3. **Summary.**—Following a suggestion that certain latex buyers in Ceylon tentatively contemplated the calculation of the per cent. d.r.c. of incoming deliveries of latex using (*a*) the per cent. total solids figure, which is more rapidly obtained experimentally than the per cent. d.r.c., and (*b*) a relationship of the type, per cent. d.r.c. = K x per cent. total solids, various tests have been made to determine how far K is likely to be independent of the original 'normal' latex and of daily variation in the latex, etc. The tests suggest that without a considerable volume of preliminary data on the latex systems involved any attempt to obtain an accurate estimate of the daily per cent d.r.c. cannot necessarily be accepted with complete confidence.

LITERATURE

1. British Standards Institution, B.S. 1672: Part I: 1950 p. 7.
2. Pidford, J. H., R.R.I.M. Planting Manual No. 4, 2nd Ed. 1947 p. 56.
3. Risdon, E. J., *et al* R.R.I.C. Quart. Circ. 1952 **28** 1-2 p. 3-6.
4. Risdon, E. J., *et al* R.R.I.C. Quart Circ. 1952 **28** 1-2 p. 7-14.
5. Risdon, E. J., Ann. Repts. R.R.B. Ceylon 1954 in press.

REPORT ON AN EXPERIMENT IN THE CONTROL OF OIDIUM HEVEAE ON RUBBER BY AERIAL SPRAYING

BY

H. E. Young

As a result of information gained from a series of trials by the Rubber Research Institute of Ceylon spread over several years it was known that wet spraying with lime sulphur solution or with wettable sulphur at 7 day intervals during the period of application gave a greater measure of control of Oidium leaf disease in rubber in Ceylon, round for round, than did sulphur dusting. The use of wet spraying on a commercial scale had however been prohibited formerly by the lack of suitable equipment which could effectively apply the spray on the foliage of mature rubber trees which reach a height of up to eighty feet.

With the introduction of better types of blast sprayers within the last few years this became possible and successful results were obtained by the use of the Micron, Mistejecta and Biatom III sprayers. With these machines however the provision of roads at frequent intervals from which the machines could operate was essential, particularly as their effective lateral throw was in the neighbourhood of sixty feet at the required tree height. It was also shown that equivalent control of Oidium could be obtained by decreasing the interval between rounds of sulphur dusting so that twice as many applications were made as with previous dusting procedures. This doubling of the number of dusting rounds in the same time interval proved cheaper than wet spraying and gave equivalent control results.

Aerial application of sulphur dust had been successfully carried out in Java in 1929 with a fixed wing aircraft but since then no work on this method of application had been further tried in the combat with the disease concerned.

The subject of aircraft application of fungicides was further considered by the Rubber Research Institute in 1948 and again in 1952 and discussions with commercial firms who carried out similar aerial spraying and dusting work in other countries on other crops were held. The commercial rubber producing industry itself also became interested in the subject and was desirous of a trial of aerial control being made.

Finally Messrs. Pest Control Ltd. of Cambridge, England offered to carry out the trial after exploratory observations by members of their staff and discussions in Ceylon with the Rubber Research Institute.

Messrs. Pest Control proposed to send to Ceylon for the 1954 Oidium season two Hiller helicopters and a fixed wing Auster Aircraft for the purpose of conducting a trial of aerial spraying using fungicidal formulations of lime sulphur and wettable sulphur based on the experimental knowledge of the R.R.I.C.

It was further proposed that an area of approximately 2,000 acres of rubber made up of land from a number of estates containing suitable clones would be most suitable for the experiment.

Messrs. Pest Control offered to carry out the work at a charge of Rs. 100/- per acre for five rounds of spraying according to an agreed upon schedule.

The proprietors of a number of rubber estates agreed to sponsor the trial on some of their areas and the Ceylon Government realizing that the trial was for the benefit of the whole industry granted a sum of Rs. 100,000 for the purpose of subsidizing its cost which at Rs. 100/- per acre was a heavy charge on the estates concerned. Messrs. Mackwoods Ltd. the Ceylon agents of Messrs. Pest Control Ltd. carried out the business arrangement for the trial in Ceylon.

The Estates taking part in the trial with the acreage of the experimental area on each estate together with the number of sprayings, application dates, and intervals between applications is shown in Table I.

Landing grounds from which to treat each spray area were arranged in co-operation with the owners of suitable lands in the vicinity.

Before spraying began it was necessary for Messrs. Pest Control's officers with the aid of a ground rig to determine the spread of the droplets on the most suitable media for field use. This was done by producing uniform sized droplets on a spinning disc and catching these on the media. In this manner the original size droplets were caught in a vaseline paraffin mixture and compared with the stains of the same sized droplets on blotters and silicone treated slides. The relation of stain size to droplet size was found to be:

3: 2: 1 for 37 per cent. lime sulphur on blotter

3: 2: 1 for 2 per cent. nigrocine on blotter

1: 4: 1 for 37 per cent. lime sulphur on silicone treated slides

1: 4: 1 for 2 per cent. nigrocine on silicone treated slides

The droplet spectra of several nozzles were then determined on a ground rig using a stationary nozzle and collecting, on blotter, the spray which passed through a slit in a revolving belt.

Preliminary Tests With Aircraft:—

(*a*) *Helicopter.*—The droplet spectra were then determined for 37 per cent. lime sulphur sprays produced by the helicopter using D2, D3 and D6 discs while flying at 35 M.P.H. It was found that the smaller the nozzle orifice the finer the spray and that with the same disc the slotted swirl plot gave a finer spray than the drilled one. The M.M.D. from the D2 spray obtained by helicopter was much larger than that from the spray obtained from the stationary nozzle. This may have been caused by the aggregation of the droplets due to their being close together in clusters of three.

Taking the through-put of the nozzles into account it was found that 120 or more of the D2, 8001 or 65015 tips would be needed to apply 4 gallons per acre at 35 M.P.H. unless the swath interval were reduced considerably below 60 feet. This was ruled out on economic grounds. As 120 or more nozzles were considered impracticable it was decided that the most suitable would be either D6 or D3. Even with the latter it was found necessary to have clusters of 2 or 3 giving a total of 89 which was the maximum number possible with the available gear. During the campaign therefore, lime sulphur was applied with 89 × D3 discs with slotted swirl plates, while wettable sulphur which was liable to block the small orifices was applied with 34 × D6 discs with slotted swirl plates.

M[ass] M[edian] D[iameter]

For wettable sulphur 4 lbs/4 g.p.a. the M.M.D. was found to be 360 microns.

(*b*) *Auster*.—For the Auster tests, spraying was carried out at 70 M.P.H. 10-12 feet above the ground.

It was found by similar tests that, as with the helicopter, the most suitable discs to use were 24 × D6 + 10 × D10 with slotted swirl plates giving an M.M.D. of 250 microns.

Swath Widths:

The swath of the helicopter was found to be 60-70 feet and that of the Auster 50-60 feet. The Auster however had to fly at 40 feet swath intervals to apply the required amount of 4 g.p.a. thus giving a good overlap.

Phytotoxic Tests:

Both 37 per cent. lime sulphur and neat lime sulphur were sprayed on young rubber leaves through D2 and D3 discs with a handsprayer. The leaves were sprayed at midday when it was considered there would be the greatest likelihood of scorch. Examination after an interval of seven days showed the following results.

(1) 37 per cent lime sulphur resulted in no scorch from the D2 and D3 discs except where overdosages occurred.

(2) Where neat lime sulphur was used there was some scorch which was more marked from the D3 nozzle than the D2.

(3) The scorch with neat lime sulphur occurred where large droplets had been or where small droplets had aggregated on the leaves.

A similar test was then carried out by helicopter except that a 37 per cent. lime sulphur spray from D6 discs was also included. On examination of the leaves four days later the only scorch observed was two spots where large drops from D6 discs had fallen. This test confirmed that the finer the spray the less likelihood of scorch and that it was quite safe to use D2 or D3 discs. The Auster sprays were similar in effect to that from the D3 in the helicopter.

Effect of Wetting Agent on Droplets:

The addition of a wetting agent usually tends to reduce droplet size. When 37 per cent. lime sulphur with and without wetting agent was sprayed through D2 discs the M.M.Ds were 250 microns and 240 microns respectively. It therefore appeared that the addition of the wetting agent did not alter the droplet spectrum and as the wetter caused difficulties in filling due to foaming it was not used for the lime sulphur spray. It was used with the wettable sulphur formulation.

Spray Campaign:

Five spray applications to each trial area at intervals of 7-10 days were considered suitable for the experiment, the commencing date being decided by each Estate Superintendent according to the development of refoliation in his trial area. Some estates were sprayed with lime sulphur at 1½ gallons in 4 gallons per acre while others were sprayed with wettable sulphur at 4 lbs in four gallons per acre.

The fields being sprayed mostly consisted of a variety of clones which due to clonal characteristics winter and refoliate at variable times. In practice it is not

possible to define and treat by air small areas of the order of 20 acres or less of a clone which requires treatment at a different time to that needed by the rest of the field. This occurred particularly with clone BD. 5 which has the character of wintering early and refoliating slowly over a period of several months. Clone BD 5 had usually been dusted from the ground by the estates concerned until the majority of the remaining clones reached the stage suitable for treatment.

The commencing date was thus a compromise in many cases and late wintering clones may have received one or two spray applications before they actually needed it and conversely no applications towards the end of the refoliation period when it was needed.

In the early stages of the spraying programme the spray distribution on treated fields was investigated. Where the trees were bare of leaves there was a good even distribution of the spray on the ground covers (usually Pueraria phaseoloides and Desmodium ovalifolium). Later when leaves formed, branches were cut from the trees for examination. In the bronze and light green stages where the leaves are very susceptible to mildew attack the young leaflets hang vertically making good spray distribution difficult. When the leaflets become more mature they become resistant to the mildew and straighten out horizontally.

Silicone treated slides were also placed amongst the rubber foliage. At first this was tried by sticking the slides to hydrogen filled rubber balloons but the weight of the cord and the slides made the balloons ascend at an angle so that the cord become tangled in the branches. The slides were therefore clipped on a cord attached to a bamboo pole and in this manner they could be placed at varying heights. The slides were placed vertically so that the spray caught on both sides would be similar to that which would fall on a leaflet.

The amount of spray caught on the slides was variable. In general there was more spray on the slides at the tops of the trees and this got progressively less lower down. The wettable sulphur spray gave a slightly coarser deposit than the lime sulphur for both types of aircraft.

The slide samples were taken when the trees were either bare or had small new leaves. Samples taken at later stages of leaf development had much less spray caught on them especially those placed five feet or more below the top of the canopy. The top canopy filtered out most of the spray. Similarly leaves examined below the top of the canopy were shown to receive progressively less spray as the top canopy became thickened by leaf growth.

The dates of spraying are given in Table I above.

From the table it will be seen that the interval between applications was for most estates irregular. This was particularly the case at the peak period and was due to one or more of the following reasons:—

(*a*) The aircraft had a much lower daily output of work than was anticipated.

(*b*) Poor flying conditions obtaining which either grounded the helicopters or only allowed operation with a reduced load.

(*c*) Rain on some afternoons which prevented further spraying for the day.

(*d*) Breakdowns which grounded the aircraft.

On a number of occasions the helicopters were unable to take off until very late in the morning as there was insufficient wind velocity until very late (sometimes 11 a.m.) to enable them to take off with the spray load.

In the case of Pallegoda estate the first two sprayings were given early in anticipation of a quick wintering of the trees. This only occurred in clone GL. 1. The other clones were not in a susceptible stage until 19-2-54 which can therefore be regarded as the first effective spray for them. On this estate the remaining sprays were at regular intervals of 7-8 days.

Horawala got regular sprays also by helicopter at 6-7 day intervals. Of the estates sprayed by Auster, only Paiyagala and Neuchatel received regular treatment at 6-7 day intervals. On the remaining estates sprayed by both types of air-craft one or more of the intervals was longer than 7-8 days.

Comparison of Treatments:

The severity of Oidium damage varies with season, clone, weather, position, elevation, etc. and the best method of assessing effectiveness of a treatment is to compare them with the results achieved by standard sulphur dusting techniques on the same or similar areas. Before spraying began these comparisons were arranged where possible using clone Tjirandji 1 which is very susceptible to Oidium attack and is one of the most difficult clones on which to control the disease, due to its long period of refoliation on individual trees. A few other clones were also included. These comparisons were arranged on eight estates—Pallegoda, Lowmont, Neuchatel, Rayigam, Ellakande, Kannana, Horawala and Dorset.

Demarcation of Plots:

In order that the boundaries of the plots and the treated strips might be visible to the pilots of the aircraft it was necessary to mark the boundaries and the strips. At first it was endeavoured to do this with hydrogen filled balloons but it was found difficult to get these through the branches without entanglement and bursting and the final procedure was to mark the strips with flags on bamboo poles set out above the tree tops. Some difficulty was experienced even with this due to the theft of the flags from the poles when left out overnight.

By using different coloured flags demarcating the plots and swathes the pilots were able to treat the areas without missing any ground or overlapping to any great extent.

Flying was carried out in most cases over difficult broken terrain and close above the tree tops. Landing and loading sites were arranged as close as possible to the areas to be treated.

Results:

In general the results of the aerial spraying were unsatisfactory as compared with normal sulphur dusting from the ground.

Penetration of the aerial sprays through the canopy was adequate until shortly after budbreak when the developing leaves prevented the spray from reaching the leaves except on the top part of the canopy. Leaf fall from the lower part of the canopy which was thus left unprotected for a large part of the susceptible stage was severe and the general final effect was a rubber field with good leaf on the top outer section of the branch system and poor leaf in the rest of the tree. On most estates

sulphur dusting had to be resorted to after the conclusion of the spray trial to save the leaf of the second refoliation which occurred due to earlier loss of leaf of the under canopy.

In one or two cases fair control was obtained by the aircraft spraying but in these cases the trees had a rather thin canopy allowing the spray to filter through and give protection to the lower leaves to some extent. The thin canopies however are not normal in any area where good control has been established for some years.

The down draught from the helicopter rotors did not effectively force the spray through the developing foliage, and the spray fell as a gentle rain. The comparative absence of down draught from the rotor blades resulted in no superior results to the spraying as applied by the fixed wing Auster aircraft in regard to its distribution in the leaf canopy.

The summarized results obtained from the individual estates are shown below in Table 2. The assessment in each case is that made by the Superintendent in charge of each estate as compared with normal dusting carried out on similar adjacent areas to the sprayed plots.

From the results it will be noted that in the great majority of cases the aerial spraying gave unsatisfactory results and that in all cases where the leaf mildew was severe control by aerial spraying was not as good as with normal dusting. In some cases where the disease incidence was light or the leaf canopy thin the aerial spraying was reported to have satisfactory results. This could be expected as in light attacks less control is necessary and with poor canopy penetration of the spray is possible even when well developed mature leaves are present.

In a large number of cases the leaves had not reached the resistant stage of development on many of the trees at the conclusion of the five rounds of aerial spraying and sulphur dusting from the ground had to be resorted to to protect the leaves for a further period.

When leaf fall was severe on the sprayed plots the leaves remaining on the trees were invariably in the top canopy.

General:

In order to carry out applications of the fungicide from the air at the regular intervals required over the areas concerned it became obvious that more aircraft would be required to allow for breakdowns, bad flying conditions etc. for the same acreage. Provision of more application units in this way would necessarily raise the cost of treatment per acre.

The actual cost of treatment for the experiment described is unknown. The charges paid per acre for the treatment was Rs. 100/-.

Sulphur dusting from the ground by the normal estate technique and applying five rounds at twelve pounds per acre each round costs from Rs. 17/- to 20/- per acre with usually satisfactory control. In severe cases dusting twice a week gives satisfactory control at approximately double the cost *i.e.* Rs. 34/- to Rs. 40/- per acre. In dusting twice a week the dosage per round is sometimes slightly reduced thus lowering the cost and giving in many cases good control.

The aerial spraying trial was very useful and as a trial successful. It was demonstrated however that under the conditions of the trial this method of Oidium

TABLE 2

Results of the Treatment

Estate	Fungicide	Severity of attack in sprayed plots	Results as assessed by Estate Superintendent
Halwatura	L.S.	Medium	Control by dusting very successful. Aerial spraying only partly.
Dorset	W.S.	Severe	Spraying was a complete failure.
Pimbura	L.S.	Medium	Spraying was unsatisfactory.
Yatadola	,,	Severe to light	No better than sulphur dusting though cost is double spraying.
Kanana	,,	Light	Spraying unsatisfactory.
Putupaula	,,	Severe to Light	As no control was available no opinion.
Pallegoda	,,	Light	Slight improvement compared with *undusted* areas.
Ellakande	,,	Severe	Dusting on the whole gave better protection.
Rayigam	,,	Medium	No marked difference.
Paiyagala	,,	Light to medium	Slightly better than dusting.
Usk Valley	,,	Light to none	Not as good as dusted areas.
Malaboda	W.S.	Severe to medium	Spraying very poor results.
Ambatenne	,,	Severe	Budded areas hand dusted have a much better foliage than the sprayed ones.
Neuchatel	L.S.	Medium	Generally satisfactory but penetration not so good as dusted areas.
Horawala	,,	Light to medium	Not much better than sulphur dusting.
St. George	,,	Severe	Not up to expectations. Sulphur dusted areas completely escaped Oidium.

L.S. = Lime sulphur
W.S. = Wettable sulphur

control on rubber trees in Ceylon was not as satisfactory as and was more costly than dusting with sulphur dust from the ground. The aerial application system also proved less flexible than individual dusting units on each estate area.

Acknowledgements:

Thanks are due to Messrs. Pest Control Ltd. for permission to use the data gathered by them in the course of the trial in regard to nozzle sizes, etc. and for carrying out the actual experiment and to Messrs. Mackwoods Ltd. for carrying out the considerable organization required.

Without the invaluable help of the Estate Superintendents concerned and their Principals the experiment could not have been carried out and the Ceylon Plantation Rubber Industry owes a debt of gratitude to organizations and individuals who participated in the trial both financially and from a practical viewpoint. The Planters' Association of Ceylon is to be congratulated for its help in organizing the trial amongst member estates.

The thanks of the Industry are also due to the Government of Ceylon for its grant of Rs. 100,000/- towards the cost of the experiment. This sum was distributed to the estates concerned, by the Rubber Research Institute as a rebate on an acreage basis towards the cost of Rs. 100/- per acre paid by the estates to the contractors. In this way a rebate of Rs. 40/- per acre was distributed.

A REVIEW OF THE PRESENT STATUS OF PHYTOPHTHORA LEAF FALL OF HEVEA IN CEYLON

BY

H. E. Young

Introduction:

Phytophthora leaf fall of Hevea caused by *Phytophthora palmivora* Butler has been present in Ceylon for very many years but until recently has not reached any great degree of importance to the plantation rubber industry there.

The same fungus causes bark rot, stem dieback and seed pod rot.

Phytophthora leaf fall has been a serious problem in the rubber areas of South India for many years and control measures are usually adopted there. It is now attaining prominence in the American plantation rubber industry and is stated to be becoming a more serious problem than the South American Leaf Blight disease caused by *Dothidella ulei* which is now being overcome by the breeding of blight resistant high yielding clones. Clones resistant to Phytophthora leaf fall are also being developed in that area by the crossing of disease resistant species of Hevea with high yielding trees of Hevea brasiliensis.

In this way clones resistant to both South American leaf blight and Phytophthora leaf fall are also in process of development.

In Malaya and Indonesia serious trouble due to Phytophthora leaf fall has not reached any recent prominence.

The present article is written with a view to setting out the position in Ceylon for consideration, suggestion, discussion and supply of data by those concerned.

The Disease in Ceylon:

In Ceylon the disease has occurred for many years in the wetter areas such as the Kalutara, Kelani Valley, and Sabaragamuwa districts following periods of fairly continuous wet weather usually towards the end of the south west monsoon in late July or August and September.

The disease commences from isolated foci in dead wood existing on the trees from the previous season.

The actual time of occurrence of suitable conditions for an outbreak of the disease is impossible to forecast accurately and in many years no outbreaks have appeared at all. It may occur at any time during the wet seasons. It has been observed that the disease usually occurs following periods of 10-14 days or more on which frequent rains fell. As will be seen by reference to advisory circular No. 45 the disease for its development requires wet conditions the optimum of which are constituted by light rains, mists and high humidities. A break in the weather of a day or two of bright weather militates against the development of the disease.

The appearance of the disease is also favoured by heavy leaf canopies which help to provide a humid wet atmosphere and shade which are essential for the best development of the fungus. Large numbers of seed pods are also conducive to the trouble in Ceylon under favourable weather conditions as the green seed pods are readily attacked by the fungus and form the main source from which infection of other parts of the tree is able to develop. Clone PB. 86 which is now widely planted in Ceylon and which is a heavy seed bearer has been found to be particularly susceptible to the disease on this account. Drifting rain particularly, carries the spores of the fungus from infected seed pods, etc. to other parts of the trees.

Heavy canopies of leaf and a good seed set have now become a common feature on most plantations due to the successful prevention of Oidium leaf fall at refoliation and to the generally increasing vigour of the trees following several years of control together with good manuring practice.

Phytophthora leaf fall outbreaks of any importance on estates are usually confined to localized areas on individual estates and frequently constitute only a small percentage of their planted area. Odd light attacks may occur on other sites. In a few cases heavy attacks have been reported.

The localized diseased areas are usually correlated with topography and occur chiefly in pockets where regular mists collect such as in closed hollows or perched pockets on hillsides particularly on western slopes, in other words where conditions conducive to the appearance of free moisture on the leaf surfaces for long periods occur.

In such leaf fall susceptible areas it is very noticeable that the worst attacks appear on trees carrying a heavy crop of seed pods. These seed pods become rotted and mummified and provide a source of spores for the severe infection of the trees concerned.

Besides leaf fall there is frequently much branch dieback caused by the disease on affected trees. These branches often persist and the fungus is able to remain viable in the dead wood and provide a source of heavy infection at the next attack.

The mummified infected seed pods usually fall off during the next North East monsoon and are gone by the next South West monsoon when disease outbreak can be expected and thus are unlikely to affect the severity of infection the following year but do appear to help and make more severe the occurrence of attacks whilst they are on the trees.

All dead and dying branches particularly in the localized areas which the estate superintendents know are liable to phytophthora leaf fall attack could with advantage be pruned off before the next phytophthora season. In pruning such branches the mistake is often made of cutting the affected branch and leaving a branch stub which in turn usually atrophies and dies due to lack of light owing to its low position under the shady canopy. This dead stub is liable to act as a source of infection in later years. The branches should be pruned off flush with their junction with another healthy branch or with the tree trunk and the wound dressed with a reliable wound dressing. The cut then heals over without leaving the dangerous dead stub.

It was at one time considered that reduction of control of Oidium leaf fall would reduce phytophthora leaf fall attack by allowing the rubber flowers to drop due to Oidium damage and thus reduce seed pod set. Such reduction of Oidium leaf fall control was advocated to be carried out by reducing the dosage of sulphur dust applied.

Unfortunately reduction of dosage of fungicide resulted not only in the falling of the flowers but in the falling of a large percentage of leaf early in the season unlike the late seasonal leaf fall due to phytophthora. Thus reduction of leaf was as large as in the case of a normal phytophthora attack and lasted the whole year with consequent deleterious and cumulative effects on the trees both in yield and vigour which was, in all, worse than the effect of the phytophthora attack and which may or may not have occurred according to the seasonal conditions present during the year.

This proposal of "partial" control of Oidium in order to prevent phytophthora attack later in the year was a complete failure in connexion with obtaining the maximum yield from the trees and retaining their vigour.

Economic Effect of the disease:

The disease as already pointed out usually occurs late in the years growing cycle and does not usually completely defoliate the tree in Ceylon. No records have yet been obtained of any reduction of crop in Ceylon due to this particular leaf fall.

This can probably be accounted for by the fact that the tree has completed the best part of the growing season by the time attack occurs and that in this time it has probably accumulated sufficient reserves to carry on normally in regard to yield until the next refoliation.

In an infrequent case an odd tree may be almost completely defoliated by the leaf fall and in such cases out of season refoliation often occurs shortly afterwards in September or October or an early refoliation appears in the normal wintering period.

Due to the lack of evidence for reduced yield and the relatively low percentage of incidence of the disease on an acreage basis (except in the case of one or two estates) it is problematical whether the expenditure of finance by most estates on control measures such as dusting is at present warranted. Sanitary measures such as dead branch pruning should however be carried out where possible as an insurance.

It can be expected in the future however that phytophthora leaf fall is likely to occur earlier in the year under appropriate weather conditions with the heavy leaf canopies now developed due to Oidium control.

The Disease in other countries:

As mentioned earlier the disease has been reported as becoming important in the American region and is definitely of importance in South India. In the American region the seasonal occurrence of the trouble is reported to be much the same as in Ceylon. Almost complete defoliations and severe dieback have been reported.

In South India the disease occurs at any time in the regular wet season in the South West monsoon which follows refoliation. An early defoliation at this time affects the tree for the whole years growing cycle with cumulative effects from year to year. This is the same position as is brought about by Oidium leaf fall in Ceylon and is therefore serious as compared with a late attack of Phytophthora leaf fall when the trees can be expected to more readily stand it without such severe effects.

In Ceylon the refoliation season is normally comparatively dry and phytophthora leaf fall has not been observed at that time, recently reports of leaf fall soon after refoliation have been made in Ceylon following the very unusual wet refoliation

season of 1955. In all such cases investigated however the trouble has been shown to be due to an attack by *Gleosporium alborubrum* and not Phytophthora.

In India control measures to prevent Phythophthora leaf fall are considered essential and the treatment of the rubber areas with copper fungicides immediately after refoliation and during the following South West monsoon has become customary.

Control of Phytophthora leaf fall:

Methods of control of Phytophthora leaf fall may be grouped as follows:—

(1) Fungicidal

(2) Sanitary practices

(3) Use of Resistant material

Fungicidal Control:

To prevent the occurrence of this disease by means of a fungicide it is essential to protect the leaves before attack with a suitable fungicide.

South Indian producers normally apply one or two rounds of a copper fungicide as a spray immediately before the regular Phytophthora seasons. In recent times dusting with copper containing dusts has also been used.

Normally Bordeaux mixture or proprietory copper sprays are applied whilst in the case of dusts both cuprous oxide and copper oxychloride formulations have been used. The cuprous oxide formulations however are reported to be rather unsatisfactory as the weight of the copper fungicide and the filler are so different and the heavy copper compound falls out of the dust to a large extent before it reaches the leaves. The copper oxychloride dusts do not have this defect to the same extent.

In the Americas the use of copper fungicides has also been reported as giving good results.

The use of other non copper containing fungicides such as the dithiocarbamate compounds has also shown to be satisfactory in nursery control in America. No results from the use of these compounds in South India are available.

Time of application of dusts:

In South India the timing of dusting operations is found to be very important.

The first dusting is delayed until as near the beginning of the South West monsoon as possible. This in practice would mean a round of dusting as early as possible after the weather breaks.

The second round and if necessary the third should be carried out in June and up to the first week in July, whenever suitable periods for dusting occur.

The dusting as in the case of Oidium should be carried out early in the morning and on wet foliage.

Secondary Effects of Fungicides:

It is well known that the presence of excess copper in rubber has a deleterious effect on the ageing of the rubber. To guard against this only a maximum of eight

parts per million of total copper are allowed in rubber under the R.M.A. specification. Such a specification however may possibly not apply to rubber used for local consumption as in South India.

The dithiocarbamate compounds are also undesirable products in raw rubber because they are very active accelerators even in very low dilution in the curing process and should therefore be kept out of the rubber as far as possible as they are likely to upset manufacturing methods.

The damage to the quality of the rubber of applying such material as copper and dithiocarbamate to the rubber tree must therefore be considered.

It is conceivable that rains after treatment with such substances will be able to wash the minute quantities of the fungicides required to denature the rubber down on to the tapping cuts whence it may find its way into the latex and certainly into the scrap rubber. In addition of course treatment with such fungicides could not be carried out whilst tapping is in actual progress.

In South India as mentioned above one or two applications of copper fungicides are usually given. Enquiries have failed so far to elicit information concerning any deleterious effects on the rubber in India due to excess copper content. This could be due to any of the following causes:—

(1) The copper does not get onto the tapping cut in sufficient quantity to adversely affect the rubber.

(2) The local manufacturers using the rubber may not be concerned with the R.M.A. specification or with an excess copper content.

(3) The trees may be resting between tappings and excess copper be removed by rain before the next tapping.

(4) The one or two copper applications may provide insufficient copper to affect the rubber.

As regards Ceylon the position is liable to be somewhat different if these fungicides are used for the following reasons.

(1) The time of occurrence of Phytophthora leaf fall is unpredictable.

(2) With an unpredictable time incidence spraying or dusting may have to be carried out over a longer period in order to anticipate attack which may occur at any time in that period.

(3) Continuous treatment may be necessary as the fungicides must be always on the leaves at infection time in order to prevent infection *i.e.* spraying or dusting at weekly to fortnightly intervals may be necessary. Treatment with fungicides after the disease has entered the leaves is useless in stopping the disease in already infected plant parts though it may act against an extension of spread but is most likely to be too late to be effective.

(4) Continuous treatment might result in an accumulation of copper or dithiocarbamate sufficient to affect the rubber.

(5) The overseas market for Ceylon's rubber might be more particular in regard to the technical properties of rubber caused by the introduction of copper or dithiocarbamates than a purely local market especially if, in the case of the former, where specialised uses are concerned and the rubber might not comply with the required copper content according to R.M.A. specification.

Sanitary Practice:

This involves the removal of diseased branches as is described earlier and could be carried out but could only be expected to reduce attack and not absolutely control it.

Use of Resistant Material:

As mentioned earlier, Heavea clones resistant to phytophthora leaf fall have been developed in America by interspecific crossing of Hevea species. The yield of these clones is not known and none of this material, so far as is known, is available in the East.

In American trials none of the eastern clones have proved reasonably resistant to the disease.

The use of low yielding resistant clones as top grafts on new plantings could be considered if the material were available.

Conclusion:

(1) In Ceylon the necessity for prevention of Phytophthora leaf fall on most estates is still doubtful at present due to lack of evidence of adverse economic effects on rubber yields.

(2) Prevention of Phytophthora leaf fall with present fungicides available at the moment without further knowledge may possibly adversely affect the market quality of the rubber produced.

(3) The help of the Industry in providing data concerning yields and possible fluctuations on phytophthora leaf fall affected trees in years of disease occurrence and without disease and compared with unaffected but otherwise similar trees would be very helpful in assessing the importance of this disease.

(4) On an experimental basis dusting with appropriate copper or dithiocarbamate dusts:

(*a*) as soon as possible after the outbreak of the South West monsoon
(*b*) about one month later
(*c*) about one month after (*b*)

would be worth considering by estates experiencing damage. Close observations on untreated control plots should be made by counting leaf fall on standard areas on such treated plots as compared with the untreated plots.

It is suggested that as recommended for South India that each dusting for the present should consist of 16 lbs per acre of at least a 6 per cent. copper oxychloride dust. Dusts containing as much as 25 per cent. copper oxychloride have been advised in India.

The dusting technique would be the same as with sulphur dusting for Oidium control and with the same machinery.

In the alternative a 2 per cent. dust containing a dithiocarbamate fungicide such as "Dithane" or Fermate could be tried.

The Rubber Research Institute would be pleased to co-operate in any estate trials in the way of advice on experimental layouts, etc. and would be grateful for any information supplied. In addition the R.R.I. will be carrying out its own preliminary trials.

MANURING AND FERTILISERS

BY

D. H. Constable

The following is intended to clear up misconceptions and confusion which we are informed exists following recent Advisory Circulars and Leaflets:—

Naming of Fertilisers:

Fertiliser mixtures containing Nitrogen (N) Phosphorus (P) and Potash (K) either alone or in a mixture are internationally named by convention according to the proportions of each nutrient present.

The convention is to put the parts of Nitrogen (as N) first, of Phosphorus (as $P_2 0_5$) second, and of Potash as ($K_2 0$) last.

Therefore 4: 6: 5 means a mixture containing 4 parts of Nitrogen (N) 6 parts of Phosphorus ($P^2 0_5$) and 5 parts of Potash ($K_2 0$).

This convention enables the user and others to recognise the type of mixture being used and compare it with others for different soil types or conditions. An order for 4: 6: 5 would bring a similarly proportioned mixture from any supplier in the world though the actual constituents might not be exactly the same. In order to lay down a definite mixture composition as well, the numbers are prefixed in our case by R making it R 4: 6: 5 which by definition in our Circular 37 is 100 parts of Sulphate of Ammonia, 100 parts Saphos and 50 parts of Muriate of Potash (50 per-cent. $K_2 0$).

The name R250 is purely a trade or proprietary name and has no meaning. Under the convention it would be taken as a mixture containing 2 parts N, 5 parts $P_2 0_5$ and nil parts $K_2 0$. For this reason we recommend its discontinuation by planters. It is not to be found in our Circulars 37, 37A and 37B.

The terms R215 and R400 are equally unsatisfactory but may be tolerated only on the score of ancient usage. We give below the correct terms for these mixtures under the convention.

A further point particularly to be noted by planters is that the old terms R215 and R400 meant 215 and 400 lbs per acre of manure per application (per year) and by analogy R250 has been taken by some to mean 250 lbs per acre per year. It should be understood that with the wide and varied distances of planting now in use, only a per tree basis of fertiliser application can be used and even this changes according to the age of the tree (as set out in Circulars 37 and 37A).

Method of calculating Fertiliser names:

R4: 6: 5 (erroneously called R250)

4 parts Nitrogen	= 20 parts Sulphate of Ammonia	= 100 parts of Sulphate of Ammonia
6 parts P_2O_5	= 20 parts Saphos	= 100 parts Saphos
5 parts K_2O	= 10 parts Muriate of Potash	= 50 parts Muriate of Potash
	50 lbs mixture	250 lbs mixture

or working the other way

100 parts Sulphate of Ammonia	= 20 parts N	giving 20: 30: 25
100 ,, Saphos	= 30 parts P_2O_5	
50 ,, Muriate of Potash	= 25 parts K_2O	or 4: 6: 5

R4: 6: 2 (more usually called R215)

4 parts Nitrogen	= 20 parts Sulphate of Ammonia	= 100 parts Sulphate of Ammonia
6 ,, P_2O_5	= 20 parts Saphos	= 100 parts Saphos
2 ,, K_2O	= 3 parts Muriate of Potash (60%)	= 15 parts Muriate of Potash
	43 lbs mixture	215 lbs mixture

or to calculate back

R400 is

290 lbs Sulphate of Ammonia	= 58 lbs N (N is 20% of Sulphate of Ammonia)
90 lbs Saphos Phosphate	= 27 lbs P_2O_5 (P_2O_5 was 30% of Saphos)
20 lbs Muriate of Potash	= 12 lbs K_2O (K_2O was 60% of Muriate of Potash)

i.e. 58: 27: 12 or more simply and approximately 10: 5: 2.

Fertiliser Prices:

We have recently included prices of fertilisers in our circulars as we understand that the Industry expects to be told the approximate cost of our recommendations. Such prices are correct at the time of going to Press but will be subject to the usual market fluctuations. We imagine that purchasers of fertilisers will make allowance for this and not regard our figures as rigid. We also hope that it will enable the Industry to recognise cases where prices perhaps rise to an unreasonable extent.

Fertiliser Analysis and Magnesium content of Saphos:

Guaranteed analyses must be given with all sales of fertiliser in respect of the nutrients for which that fertiliser is described as a supply source. The use of the NPK proportion convention mentioned ensures that the buyer gets what he orders.

No guarantee is given or implied in regard of nutrients described as additional or minor constitutents nor should any be expected. Firms may however in all good faith state the expected content of any minor constituent which may be of interest and such a statement should be taken at that face value.

For example Saphos has recently been available with a Magnesium (M_gO) content varying from 2.3-3.0 per cent. Firms cannot be expected to guarantee this as they are selling *Phosphate* fertiliser but they may be prepared to state the probable percentage of Mg. *e.g.* over 1 per cent. or over 2 per cent. as the case may be.

We are informed that no further material has been received with such high MgO analysis since the four separate shipments which formed the basis of our recommendation in "Deficiency Symptoms in Hevea".

We regret any inconvenience or embarrassment caused by the subsequent decline in Magnesium content of Saphos and the inability of Companies to obtain further supplies of this better grade (in terms of Magnesium) Saphos.

Best form of Magnesium:

Magnesium Sulphate costs approximately 11 cents per lb and Dolomitic Lime approximately 5 cents. In the first year we recommend ½ lb Dolomitic Lime per tree = 2½ cents per tree plus cost of application or using 50 lbs of Magnesium Sulphate added to 250 lbs of R4: 6: 5. This latter mixture is used at 1-1¼ lbs per tree of which the Mag. Sulphate forms 50/300 parts or one sixth. One sixth of one lb of Magnesium sulphate is therefore used, costing 11 cents per lb or 2 cents per tree with no extra cost for application. Magnesium Sulphate is therefore cheaper than Dolomite.

Another point of view is that although the cost of Mag. Sulphate per lb is six cents more, if the Magnesium Sulphate works very much more quickly than Dolomite then the extra period of deficiency free growth might be worth the extra cost.

We hope that this explains our final paragraph of "Deficiency Symptoms".

RUBBER RESEARCH INSTITUTE OF CEYLON

Minutes of the 135th meeting of the Rubber Research Board held at the Office of the Rubber Controller, Eastern Bank Building, Colombo, at 2-30 p.m. on Wednesday 16th March, 1955.

Present:—Mr. S. Pathmanathan (in the Chair), Mr. G. H. Carter, Mr. W. P. H. Dias, J.P., Mr. G. H. Dulling, Mr. Errol Jayewickrema, J.P., Dr. A. W. R. Joachim, O.B.E. (Director of Agriculture), Major T. F. Jayewardena, M.P., Mr. B. Mahadeva, C.C.S. (Rubber Controller), Mr. R. H. Wickremasinghe, C.C.S. (Acting Deputy Secretary to the Treasury), Senator C. F. W. Wickramasinghe, Dr. H. E. Young (Director R.R.I.C.), and Mr. C. D. de Fonseka (Administrative Secretary).

1. **Board:**—The Chairman welcomed:

(*a*) Mr. R. H. Wickremasinghe, Acting Deputy Secretary to the Treasury, whose nomination had been reported at the last meeting.

(*b*) Mr. G. H. Dulling who had resumed his seat on return from leave with effect from 15th February, 1955, relieving Mr. H. Creighton who had acted for him. Mr. Creighton was thanked for his services.

The Chairman also reported that Mr. G. H. Carter would be going on leave shortly. It was agreed that Mr. Carter be given six months leave of absence from 1st April, 1955, and that the Planters' Association of Ceylon be asked to nominate a member to act during this period.

2. **Minutes:**

(*a*) *Confirmation.*—Draft minutes of the meetings held on 17th January and 2nd February, 1955, which had been circulated to members, were signed by the Chairman.

(*b*) *Matters arising from the minutes:*

Estate Superintendent.—The Selection Committee's recommendation that Mr. L. Wijeyagunawardene, the present Acting Estate Superintendent, be appointed Estate Superintendent was approved.

3. **Reports and Accounts:**

(*a*) *Chairman's and Director's reports for* 1954.—These were approved for publication and general satisfaction was expressed at the results achieved during the year.

The yield results of Institute bred clones mentioned in the Botanist's report and the responses to manurial treatment stated in the Agronomist's report were noted with satisfaction.

(*b*) *Receipts and Payments Account for the* 4*th Quarter* 1954.—was approved.

(*c*) *Redemption of Ceylon Government 3 per cent. Defence Loan* 1954.—The transfer to current account of the proceeds of Rs. 15,000/- stock of Ceylon Government 3 per-cent. Defence Loan which had matured on 1st December, 1954, was reported.

4. **Estate Items:**

(*a*) *Survey of Hedigalla and Nivitigalakele.*—Recently prepared plans of Hedigalla and Nivitigalakele divisions were tabled.

5. **Staff:**

(*a*) *Research Asst. Agronomy Dept.*—The progress report of Mr. A. J. Jeevaratnam, Research Asst. Agronomy Dept., for the period November, 1954 - February, 1955 was tabled and it was noted that Mr. Jeevaratnam had obtained a B.Sc. Agriculture Honours degree and was now preparing for the M.Sc. Agriculture degree.

(*b*) *Asst. Staff Association.*—A letter from the Hony. Secretary of the Assistant Staff Association requesting that the designations of Laboratory Assistants, Conductors-in-Charge and Experimental Conductors be changed to Technical Assistants, Senior Field Assistants and Field Assistants respectively was considered. The request was approved provided that no change in salary scales is involved.

6. **Publications:**—The following publications were tabled:—

Advisory Circular No. 45—Phytophthora Leaf Disease and Stem Dieback of Hevea.
do. No. 46—White Root Disease of Hevea.
do. No. 47—Ustulina Rot of Rubber Trees.
do. No. 48—Brown Root Disease of Hevea.
do. No. 50—Orange Gall of Hevea.
do. No. 51—Bird's Eye Leaf Spot of Hevea.

7. **Next Meeting:**—It was agreed that the next meeting of the Board be held on Wednesday, 18th May, 1955.

RUBBER RESEARCH INSTITUTE OF CEYLON

Minutes of the 136th meeting of the Rubber Research Board held at the Rubber Controller's Office, Colombo, at 2-30 p.m. on Wednesday 18th May, 1955.

Present:—Mr. S. Pathmanathan (in the Chair), Mr. H. St. J. Cole Bowen, Mr. W. P. H. Dias, J.P., Mr. G. H. Dulling, Major T. F. Jayewardene, M.P., Mr. Errol Jayawickrame, J.P., Dr. A. W. R. Joachim (Director of Agriculture), Mr. R. H. Wickramasinghe (Deputy Secretary to the Treasury), Senator C. F. W. Wickramasinghe, Dr. H. E. Young (Director), and Mr. C. D. de Fonseka (Administrative Secretary).

Mr. B. Mahadeva (Rubber Controller) had expressed his inability to attend the meeting.

1. **Board:**—The Chairman reported that:

(*a*) Mr. H. St. J. Cole Bowen had been nominated by the Planters' Association of Ceylon to act for Mr. G. H. Carter during the latter's absence from Ceylon with effect from 1st April, 1955. It was agreed that Mr. Cole Bowen should serve on the Experimental Committee in place of Mr. Carter.

(*b*) Senator C. F. W. Wickramasinghe had been re-nominated by the Minister of Agriculture and Food to represent the Senate for a further period of three years with effect from 21st July, 1955.

2. **Minutes:**—Draft minutes of the meeting held on 16th March, 1955, which had been circulated to members, were signed by the Chairman.

3. **Experimental Committee:**

Recommendations made at meeting held on 26th April, 1955.

(*a*) *Visiting Agent's report.*—The recommendations regarding stream reservations, buildings and lines and cover crops were approved and the balance of the 1954 Capital vote for roads was revoted for 1955 to enable the year's programme to be completed. The tarring of about quarter mile of the approach road to Hedigalla in places where tarring is necessary to maintain the road in good condition was approved.

(*b*) *Visiting Engineer's report.*—The recommendation that in future the Visiting Engineer be asked to report on the adequacy of existing insurance cover on the Institute's buildings and equipment was approved.

(*c*) *Retiring gratuities to estate labourers.*—The payment of retiring gratuities at rates recommended by the Ceylon Estate Employers' Federation to four labourers who had reached retiring age and had expressed their willingness to retire was approved.

(*d*) *Staff Club.*—The recommendation that the R.R.I. Staff Club be permitted to run a beer bar in the Club premises for the use of its members was approved.

(*e*) *Publications.*—The Committee's recommendation was that in view of the technical nature of the contents of Quarterly Circulars and Annual Reports these publications should not be issued to smallholders (*i.e.* owners of rubber estates of less than 30 acres in extent) and that the S.H.P.O. be asked to extract from these publications such information as would be applicable to smallholders and prepare publications in non-technical language for issue to them in English and Sinhalese. The Committee had further recommended that Advisory Circulars should be issued to both classes of estate owners and that they should be translated into Sinhalese for issue to those who prefer to have them in that language. Also that each smallholder may elect to receive publications in English or Sinhalese as desired by him. These recommendations were approved.

The following publications were tabled:—

1. Combined 3rd and 4th Quarterly Circular for 1954.

2. Bulletin No. 55—Manurial Diagnosis for Hevea Brasiliensis Part I. General Discussion and Field Results.

3. Booklet "Deficiency Symptoms in Hevea Brasiliensis in Ceylon".

The minutes were adopted.

4. **Reports and Accounts:**

(*a*) *Balance Sheet and Income and Expenditure Account for* 1954.—It was reported that these had been submitted to the Auditor General for examination but that his report had not yet been received. The Balance Sheet and Income and Expenditure account were adopted subject to audit.

(*b*) *Supplementary Votes and Revotes.*—Two supplementary votes for Rs. 1,619/- were passed and balances of 1954 Capital votes amounting to Rs. 147,140/- were revoted for 1955.

5. **Technical Matters:**

(*a*) *Report on aerial spraying.*—The report on the aerial spraying trial carried out during the 1953/54 Oidium season by means of helicopters was considered. It was noted that although the trial was successful it demonstrated that this method of Oidium Control was more costly and not as satisfactory as dusting with sulphur dust from the ground. The report was approved.

(*b*) *Report on sulphur dusting trial at Kegalle.*—The report on the trial sulphur dusting scheme carried out on smallholdings in the Kegalle district during the last oidium season was considered and it was noted that the cost per acre over the dusted area was Rs. 48/78. As this was beyond the means of the average smallholder it was considered that the best method of assisting the smallholders in dusting their holdings would be by the formation of small co-operative groups each of which would have a sufficient acreage for a dusting machine. The necessary technical advice would be given by Rubber Instructors of the Smallholdings Department and the necessary dusting machines could probably be obtained by Government through the Technical Aid Plan. The co-operatives could then function using their own sulphur and labour. The Director was asked to prepare a suitable scheme for the formation of such co-operative groups and to request the Minister of Agriculture and Food to supply one dozen dusting machines for this purpose.

(*c*) *Sale of creamed latex.*—In view of requests for large quantities of creamed latex from certain firms which manufacture rubber goods, the Board considered its policy in this matter and agreed that it could not supply a larger quantity than already estimated for and that it could not purchase latex from outside estates for processing and sale. Further consideration of the subject in regard to quantities, price, etc. of creamed latex manufactured from available crop was referred to the Experimental Committee.

6. **Staff:**

(*a*) *Plant Pathologist.*—After considering the work done during the last Oidium season since the departure of Mr. Van Emden, it was agreed that the post of Plant Pathologist be advertised forthwith as widely as possible and that an application be made to secure a suitable officer through the F.A.O. or Technical Aid Plan.

(*b*) *Assistant Staff.*—Changes in staff since the last meeting were reported.

7. **London Advisory Committee:**

Draft minutes of the 61st meeting of the Committee and 5th and 6th meetings of the Agricultural Sub-Committee.—were tabled.

8. **Next Meeting.**—It was agreed that the next meeting of the Board be held at the Rubber Controller's Office at 2-30 p.m. on Wednesday 13th July, 1955.

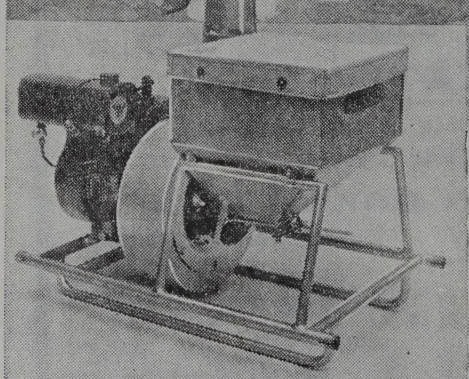
9. **Rubber seed garden at Ratmalagara.**—In connection with the seed garden established at Ratmalagara Estate on a two acre block leased from the Coconut Research Institute it was reported that all the information required therefrom had now been obtained and it was agreed that the lease be terminated.

The meeting terminated at 4-50 p.m.

Printed for the RUBBER RESEARCH INSTITUTE OF CEYLON, *Dartonfield, Agalawatte, by* H. W. CAVE & CO., LTD., *Fort, Colombo.*

KESTREL

POWER POWDER DUSTER



THE IDEAL MACHINE
FOR ALL
YOUR DUSTING.

Easy and cheap to operate
Weight only 90 lbs.

HAND MACHINES ALSO AVAILABLE.

ENQUIRIES INVITED BY

BROWN & CO., LTD.,

ESTABLISHED 1875

COLOMBO — HATTON — NAWALAPITIYA.

RUBBER RESEARCH INSTITUTE OF CEYLON

STAFF

Director ...	H. E. Young, D.Sc. Agri., A.I.R.I.
Technical Assistant to the Director ...	O. S. Peries, B.Sc. Agr.
Chemistry Department	
Chemist ...	E. J. Risdon, M.A., D.Phil., A.R.I.C., A.I.R.I.
Research Assistant ...	M. Nadarajah, B.Sc.
Technical Assistants ...	D. S. Muthukuda, M. T. Veerabangsa and G. G. Gnanasegaram
Botany Department	
Botanist ...	C. A. de Silva, B.Sc., C.D.A.
Research Assistant ...	L. B. Chandrasekera, B.Sc. Agr.
Plant Breeder ...	O. S. Peries, B.Sc. Agr. (Acting)
Computer ...	W. G. V. Fernando
Technical Assistant ...	C. Amaracone
Mycology Department	
Mycologist & Oidium Research Officer ...	C. A. de Silva, B.Sc., C.D.A., (Acting)
Assistant Mycologist ...	D. M. Fernando, M.Sc.
Technical Assistants ...	H. L. Munasinghe and E. G. Mendis
Agronomy Department	
Agronomist ...	D. H. Constable, M.Sc., D.I.C., A.R.C.S.
Research Assistant ...	A. J. Jeevaratnam, B.Sc. Agr.
Technical Assistant ...	T. C. Z. Jayman
Estate Department	
Superintendent ...	L. Wijeyegunawardena
Officer-in-charge, Egal Oya Nurseries ...	H. M. Buultjens
Senior Field Assistants ...	D. C. Kannangara, L. P. de Mel and J.Pitchamuthu.
Head Estate Clerk ...	T. S. J. Peiris
Senior Artisan ...	T. C. Fernando
Clerks (3)	
Rubber-Maker, Apothecary, Electrician and Workshop-Foreman	
Field Assistants (5)	
Smallholdings Department	
Smallholdings Propaganda Officer ...	W. I. Pieris, B.A. Hortic.
Assistant Propaganda Officers ...	N. W. Palihawadana, K. Wilson de Silva, and H. H. Peiris
District Field Officers ...	D. R. Ranwala, P. S. G. Cooray. D. E. A. Abeywickrema and B. D. Pedrick
Rubber Instructors (36) ...	
Clerks (5) ...	
Administration	
Administrative Secretary ...	C. D. de Fonseka, A.C.C.A., A.C.C.S.
Chief Correspondence Clerk ...	J. A. Attygalle
Clerks (9); *Clerk-Librarian and Storekeeper*	

Note.—The Laboratories and Head Quarters Offices of the Institute are situated at Dartonfield Estate, Agalawatta, Telephone No. 26, Agalawatta, Telegraphic address 'Rubrs' Agalawatta. There are two Experimental Stations, one at Nivitigalakele, Matugama, and the other at Hedigalla, Latpandura. The Office of the Smallholdings Dept. is at No. 33 Clifford Place, Colombo 4. Telephone No. 84205, Colombo.

All enquiries and other communications should be addressed to the Director, Rubber Research Institute of Ceylon, Agalawatta.

253, 256